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An evaluation of the 4X haddock population characteristics during 1962-81 with yield projected to 1983

by

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[1] This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the Research Documents it contains are not intended as definitive statement on the subjects addressed but rather as progress reports on ongoing investigation.

Abstract

Prior to 1960, annual 4X haddock landings fluctuated between 10-20,000 t. During the mid to late 1960's, heavy exploitation by both foreign and Canadian fleets resulted in catches in excess of 30,000 t and the subsequent rapid decline in stock abundance. Quota regulations have been in force since the early 1970's. Since 1977, the annual landings have steadily increased. The 1981 TAC of 28,000 t was exceeded by over 3,000 t and the 1982 TAC has been established at 32,000 t. The observed catch trends have been followed in both the Canadian summer and US autumn groundfish surveys, although they differ specific details. The present assessment used a combination of the "Survivor Method" and Cohort Analysis to derive the 1981 stock size similar to the procedure carried out in the previous assessment of this stock. The view of stock status is considerably more pessimistic than in previous years. The 1981 terminal fishing mortality was set at 0.4 although there was evidence to suggest that it could be as high as 0.45. The reasons for this change in the assessment are due to better recent sampling and to more reliable catch rate data. Using the derived partial recruitments and the 1981 weight at age, a series of yield projections were made to 1983 assuming $F_{0.1}$ catch in 1981 and 32,000 t for 1982. The estimated 1983 catch of 30,000 t is not substantially different from the 1982 TAC. Thus there are no grounds on which to base a recommendation for a change in the 1983 TAC.

Résumé

Les débarquements d'aiglefin de 4X avant 1960 ont varié entre 10 et 20 000 t. Du milieu à la fin des années 1960, une exploitation intense par les flottilles, tant étrangères que canadiennes, résulta en des prises dépassant 30,000 t et, par la suite, en un rapide déclin du stock. On introduisit des contingents au début des années 1970 et, depuis 1977, les débarquements annuels ont augmenté régulièrement. Le TPA de 28,000 t en 1981 a été dépassé de plus de 3 000 t, et celui de 1982 a été fixé à 32,000 t. Ces même tendances ont été observées dans les relevés de poissons de fond par navires de recherches, tant canadiens en été qu'américains en automne, bien que les relevés des deux soient quelque peu différents dans les détails. Dans la présente évaluation, nous avons combiné la "méthode des survivants" avec l'analyse des cohortes afin de déterminer l'effectif du stock en 1981 de la même manière qu'antérieurement. Cette dernière évaluation nous porte à être beaucoup plus pessimiste qu'auparavant. La mortalité de dernière année en 1981 avait été établie à 0,4, mais on a des indications qu'elle a pu être aussi élevée que 0,45. Un tel changement dans l'évaluation est dû à un échantillonnage amélioré et à des données plus fiables sur les taux de capture. Utilisant les recrutements partiels ainsi obtenus et les poids par âge en 1981, nous avons fait des projections de rendement jusqu'en 1983 en supposant des prises au niveau de $F_{0,1}$ en 1981 et de 32 000 t en 1982. Ceci donne des prises de 30 000 t en 1983, pas très éloignées du TPA de 1982. Nous recommandons donc de ne pas modifier ce TPA.

Introduction

In 1981, the "Survivor" method of Rivard (1980) was introduced to aid in the assessment of the 4X haddock stock. This procedure allows more objective determination of the current year's fishing mortality than has previously been the case.

This document presents a similar analysis to that in O'Boyle (1981b). Again, a mixture of "Survivor" and SPA methodology is used to determine the 1981 stock size and consequently project 1983 yield. The section describing catch and its age composition has been considerably expanded to include a discussion of temporal and spatial trends in the fishery. Also an analysis of growth trends in the population over the 1962-81 period has been added.

Trends in Reported Landings

Annual Trends

During 1930-60, catches of haddock from Division 4X (Figure 1) fluctuated between 10-20,000 t. These landings were split equally between Canada and the U.S. In 1963, the USSR first entered the fishery, reporting a catch of 400 t. Their involvement in the fishery increased until 1966, when they reported catches of 10,065 t. Subsequent to this, the USSR did not undertake a directed 4X haddock fishery (Figure 2). During the same period, the Canadian otter trawl fleet expanded rapidly, particularily the tonnage class 4 fleet component (Figures 3 and 4).

The increased effort in the fishery resulted in a peak in reported landings of 37,116 t in 1966. Catches remained high until 1969. The high exploitation rates experienced by the stock led to dramatic declines in abundance, and provoked the establishment of quotas and restricted fishing area regulations in 1970.

The stock showed signs of recovery in the mid-late 1970's. Since 1973, when 12,958 t were landed, the annual catch has steadily increased, with over 30,000 t reported landed in 1981 (Figure 2 and Table 1). The vast majority of this yield is due to Canadian fishing. Indeed, it is now apparent that recovery was greater than analyses at the time stated (O'Boyle 1980). Quotas during the 1975-79 period may have been set too low as discarding and misreporting became severe problems. For this reason, reported catches are likely to be conservative.

During 1979-81, the offshore fleet underran and the inshore fleet overran their respective allocations (Table 2). In an attempt to regulate the inshore and offshore fleets more efficiently, the 1982 groundfish management plan considers allocations for 3 rather than 2 vessel size categories.

Canadian Fishery by Gear Type and Tonnage Class

Otter trawlers have dominated the fishery since its inception. Landings by these vessels have increased dramatically since 1973 (Figure

3 and Table 3). Catches by longliners have remained constant around 4-6,000 t annually since the early 1970's.

Historically, tonnage class 4 and 5 otter trawlers contributed most to the fishery (Table 4 and Figure 4). Since 1976, tonnage class 1-3 vessels have become the dominant fleet components. Virtually all the historical tonnage class 4-5 vessel landings have been from unit areas N and P (Figure 1). With the gradual disappearance of these vessels from the fishery, the tonnage class 1-3 vessel landings have increased in unit areas N, O, P, and Q. Activity in unit area R has always been high for these smaller vessels (Table 5).

Canadian Otter Trawler Fleet Activity by Month and Unit Area

Generally, the larger offshore vessels fish in unit areas 4Xn and 4Xo at the beginning and end of the year. Prior to 1979, fishing in 4Xp (Brown's Bank) in the summer months was common. However, this was not the case in 1979, 1980, or 1981 due to quota and allocation restrictions (Table 6).

The activity of the small trawlers varies considerably over the season. Fishing usually commences early in the year in unit areas N and O, shifts to unit area Q during May-June and continues until the late fall in unit area R (Table 7). With minor variation this pattern has remained the same since the early 1970's.

Age Composition of the Commercial Catch

Sampling Intensity

Sampling of catch from the various gear types has generally been good (Table 3). However, prior to 1981, coverage within gear type by tonnage class has been strongly biased towards the larger vessels (Table 4). For this reason, sampling of catches made in unit areas 4Xq and 4Xr has been poor. This is unfortunate in that the available sampling data suggests that fish caught in the Bay of Fundy are generally younger than those caught on the Bank (Figure 5). This is particularily true of tonnage class 1 vessels fishing in St. Mary's Bay and the many reasons for this size difference discussed by Waldron and Iles (1982).

In 1981, sampling effort was redistributed from the large offshore vessels to the tonnage class 1-3 vessels. Thus the current catch- at-age composition is more representative of landings age-size composition than has previously been the case.

Construction of the Catch-At-Age Matrix

The age-size composition of the landings from 1962-77 was constructed as per O'Boyle (1980) (Table 8). The 1978-79 catch-at-age was reconstructed as per O'Boyle (1981b). The 1980-81 catch-at-age was determined as follows: the otter trawler, longliner and miscellaneous gear catches were sorted by gear type into 2 areas, 4Xm-4Xp and 4Xq-4Xr, and 4

seasons. Then the samples for these areas, gears, and quarters were combined and applied to the catches.

For the 1978-81 catch-at-age, only Canadian samples have been used. As well, no attempt has been made to adjust for discarding.

The Catch-At-Age Matrix

The 1962-81 catch-at-age composition is provided along with the weights-at-age in Table 8.

In 1981, the 1975-77 year-classes contributed over 70% to the total landings. Over the last 3 years, age 4 to 7 fish made up most of the yield (Table 9). In almost all years, fish older than 12 have contributed little to landings.

Stock Abundance Trends

Canadian Summer Bottom-Trawl Survey

The 1979 and 1980 year-classes appear very strong in the 1981 Canadian summer survey (Table 10). The 1981 0-group catch was the highest ever seen. Also the 1977 year-class still appears to be strong. The 1975 year-class, on the other hand, has been effectively fished out.

The strength of the younger age groups in the population has led to an increase in the numbers-per-tow since 1978 without a concomitant increase in the weight-per-tow. The latter has remained stable since 1979.

It is interesting to note that, for the last 3 years, the highest catches have been in stratum 90 (Figure 6a) whereas historically the numbers-per-tow were highest on Brown's Bank (Table 11). The survey data, split by age-group and strata (Table 12) suggest that the young age groups presently in the fishery are more prevalent in the Bay of Fundy area.

The relative contribution of each stratum to the overall survey abundance and variance (Table 13) was calculated as in O'Boyle (1981b). On average, seven tows are responsible for more than 50% of the mean catch rate and variance in each year. The 1981 estimate was based largely on 5 tows.

U.S. Fall Bottom Trawl Survey

The U.S. fall survey results for strata 31-34, (Figure 6b) the only ones consistently sampled for 1963-81, are in Table 14.

The data for 1981 is incomplete. Nevertheless, recent recruitment appears good, in general agreement with the Canadian survey. However, overall stock abundance trends differ between the two surveys. The U.S. series shows rapid increase in biomass during the 1975-78 period whereas the Canadian series exhibits a moderate increase over the 1976-81 period. This discrepancy is much less when only the data for Brown's Bank proper

are considered (Figure 7). This emphasizes the importance of complete areal coverage in these surveys. Unfortunately much of 4X is unsampled (Figure 6) in either survey, due to untrawlable bottom. For this reason, the survey data must be used in conjunction with commercial catch rates.

Survey Recruitment Indices

Recruitment indices were calculated from the Canadian summer using the normalization method of O'Boyle (1981a). Age 1 and 2 fish were used for the Canadian surveys and age 2 and 3 fish for the U.S. surveys.

Both surveys indicate that present recruitment levels are much higher than those observed in the 1960's (Figure 8). The 1979 and 1980 year-classes are strong in both surveys.

An interesting feature of the data is that year-class strength does not appear to have been determined by the fall. Both the U.S. and Canadian fall surveys collected large quantities of the 1980 year-class as 0-group. The following July, this year-class appears smaller than that of 1979. This suggests substantial mortality of this year-class over the 1980-81 winter (Table 15).

Commercial Catch Rates

Two new commercial catch rate series were developed. These are:

1) Stern otter trawlers (TC 2 and 3) operating in 4Xq-r during May-August. Their catch is mainly haddock.

2) Stern otter trawlers (TC 4 and 5) operating in 4Xn during January-March. Their catch is mainly haddock.

In addition the catch rate of pollock for the tonnage class 2 and 3 vessels whose catch is mainly pollock was examined. It has been reported that a considerable amount of misreporting of haddock as pollock occurred during the 1976-79 period. It was thought that this might be exhibited in the commercial catch-rate series.

The pollock and haddock catch rates in 4Xq-r follow similar trends (Figure 9). The pollock catch rate has dropped off since 1979 whereas that for haddock has stayed fairly constant. If much of the pollock reported during the 1976-79 period was indeed haddock, then these data indicate that commercial catch rates for haddock have declined dramatically since 1978-79. Reports from the fishery that present catch rates are not as high as those observed during the 1978-79 period are consistent with the above observations. Due to their preliminary nature these findings cannot be used to quantitatively adjust the assessment. They do, however, indicate that the stock abundance may be declining faster than thought previously (O'Boyle 1981b).

All catch rates indices (Table 16 and Figure 10) shows substantial increases in catch rate during 1976-79. However, the TC 2 and 3 index

increases 2-3 years before than the others. As stated earlier, this fleet exploits younger fish than the larger vessels. The catch rate for the smaller vessels has declined since about 1980. This is in agreement with the survey data which shows a pulse of strong year-classes moving through the fishery during the late 1970's.

Growth Trends

The 4X haddock stock has exhibited pronounced changes in abundance and size-at-age during the 1962-81 period. Yield calculations are sensitive to changes in growth. If growth parameters are changing rapidly, projections based on current growth may be seriously biased. Such a situation calls for the use of time series and forecasting methods. The first steps in any such analysis must be exploratory. In this spirit, two regression analyses were conducted using age and length data obtained during the Canadian summer research vessel surveys in the years 1970-1981.

The first analysis employed observations on 2,512 individual fish from cruises in 1977-1981. Non-linear least-squares regression was used to fit the model

$$L = -G \cdot \mathrm{Exp}(-K \cdot A) + LINF$$

where: L = length (cm)
A = age (years)
K = Brody growth parameter
G = parameter
LINF = asymptotic length (cm)

This model is a reparameterization of the usual von Bertalanffy growth curve. The least squares fit was obtained using the BMDP3R program (Dixon and Brown 1977) on the central computer at BIO. Analysis of variance on the residuals was conducted using the BMDP7D program and groupings by age, year, and year-class. A significant time trend in the residuals (Table 17) was found. These results suggested that the growth parameters should be viewed as functions of time. As a first step towards a model in which these parameters would be related to other variables (eg. population) each parameter was assumed to be a polynomial function of time. Roughness constraints were added to the model following a suggestion by Huber (1979). The time span considered was increased to 1970-81, but the data used were mean lengths-at-age. Because the necessary information is not provided in the printouts from which test data were obtained, it was not possible to define proper case weights for these regressions. A large-residuals least squares regression subroutine NL2SOL (Dennis et al. 1979) was used to minimize the sum of squares:

$$[L_i + G(t_i) \cdot EXP\ (-K(t_i) \cdot A_i) - LINF(t_i)]^2$$

$$+ \ _1 \qquad [G(t_{i-1}) - 2\ G(t_i) + G(t_{i+1})]^2$$

$$+ \lambda_2 \quad [K(t_{i-1}) - 2\,K(t_i) + K(t_{i+1})]^2$$

$$+ \lambda_3 \quad [LINF(t_{i-1}) - 2\,LINF(t_i) + LINF(t_{i+1})]^2$$

where L_i is now the mean length-at-age A_i and the parameters were polymonials in time, t_i. For a proper analysis one would employ a more flexible class of function (eg. splines) and the weights λ_1, λ_2, λ_3 would be chosen by cross-validation (Stone 1974; Efron 1982). This level of sophistication was, however, not appropriate considering the inability to obtain case weights and the exploratory nature of the analysis.

Preliminary runs were used to reject outliers and determine the appropriate degree for the polynomials. A reasonable fit was obtained using cubic polynomials, $\lambda_1 = \lambda_2 = \lambda_3 = 1$, and ages 3-11, with 4 observations (1978, ages 9-11 and 1979, age 11) excluded. A full series of diagnostic plots was generated. These were generally acceptable, although the strongest (1963) and weakest (1970) year-classes in the series produced fish which were smaller than expected. The observed and predicted lengths are shown in Figure 11.

This preliminary analysis does not support a single relation between population size and growth. At the very least it would be necessary to postulate a lag mechanism. The small size of fish in the 1963 year-class suggest that factors affecting year-class size (and thus operating early in life) may also influence growth. While the available data are adequate to demonstrate the existence of trends, they lack the resolution required to develop predictive models.

The comparison with a similar analysis conducted on the 4VW haddock stock (Mahon et al. MS 1982) is interesting. While the overall pattern is similar, the recent decline in growth affected all ages in 4VW haddock at the same time. In the 4X stock the decline occurred first for young fish (in 1978 or 1979) and has not yet become evident for fish above age 8. Recent abundance trends in the two stocks suggest a more rapid increase in density for the 4VW stock, which may be a factor. Alternately the 4X stock may exploit a more heterogeneous resource which provides some decoupling of growth by different age groups. The latter hypothesis is consistent with the more complex topography in division 4X.

Sequential Population Analysis

Determination of Fully Recruited Fishing Mortality in 1981

A first estimate of 1981 F_r (Terminal fishing mortality) was obtained by the Survivor Method (Rivard 1980). Two runs were made, one using ages 2 to 9 while the other used ages 3 to 8 of the Canadian summer survey numbers-per-tow and the catch-at-age. The same endpoint criteria were used as in O'Boyle (1981b) i.e. calibration block with final year in 1979, final age at 7 with K (calibration constant) leveling off at age 6. Natural mortality, M, was 0.2. Fishing mortalities for 1981 were calculated by inputing the survivor estimates and catch

statistics for 1981 into a Newton-Raphson iterative solution of the Baranov catch equation. Adjustment of the survivor estimates from end to beginning of year values was also carried out.

The results of the "Survivor" analysis are provided in Table 18 (a and b) and Figure 12.

Full recruitment is evident at age 5, one year younger than assumed in last year's assessment. The weighted mean F_r for ages 5 to 7 was 0.485 in the age 3-8 run and for ages 5 to 8 was 0.462 in the age 2-9 run. These terminal fishing mortalities represented a considerably more pessimistic view of the stock than presented in O'Boyle (1981b).

A series of cohort analyses were conducted to compare population parameters with those derived by the "Survivor" analysis. Five runs were conducted covering fishing mortalities of 0.3 to 0.5. Partial recruitment values were those generated in 1981. Five abundance indices were used:

1) Age 2+3 numbers from SPA vs age 2+3 Canadian summer survey numbers-per-tow for same year-class.

2) Age 2-5 numbers from SPA vs age 2-5 survey numbers-per-tow.

3) Age 6+ numbers from SPA vs age 6+ survey numbers-per-tow.

4) Ages 2-4 biomass from SPA vs trawler (TC 2+3) catch-rate.

5) Age 4+ biomass from SPA vs trawler (TC 4+5) catch-rate.

Indices 2, 3, and 5 were given the most weight in determining F_r.

Correlation analyses for the various runs (Table 19) provided little basis to select a 1981 F_r. Examination of the plots for each run indicated that F_r of 0.4 seemed to place the 1978-81 points in line with historical trends better than the other F_r's used. This analysis is more in line with the results provided by O'Boyle (1981b). However, as mentioned earlier, the commercial catch-rate indices may indicate a substantial recent decline in stock abundance, an observation consistent with the Survivor Analysis. It was felt that until the above observation can be confirmed, more weight should be put on the Cohort Analysis. Also, the Survivor Analysis depends solely on the research data, which does not cover the whole of 4X. Thus a 1981 fishing mortality of 0.4 was chosen for this assessment.

Determination of Terminal Fishing Mortality for Age 12 in Each Year

As in O'Boyle (1981a) an iterative procedure was used. Only 4 interactions were required to meet the convergence criterion of 0.001.

1981 Partial Recruitments

The Survivor Analysis provided a a full recruitment at age 5. The recruitment-at-age 4 was 0.44, compared to 0.6 in O'Boyle (1981b). Due to

the uncertainties of "Survivor", a series of runs was made using different partial recruitments, at an F_r of 0.4. The results of these runs are given in Table 20. The most striking feature is that the correlation coefficients of the various relationships examined change very little from one combination to the next. For this reason, a rather subjective method was used to fix the 1981 partial recruitments.

First, the age 1 and 2 partial recruitments was fixed by examining the age 1+2 SPA and age 2+3 SPA relationships. The age 3 partial recruitment was estimated to be 0.3 as this value appeared to generate the best overall relationship. Age 4 partial recruitment was estimated as 0.6, the same as in O'Boyle (1981b). Full recruitment was assumed to be age 5.

The chosen partial recruitment vector was very similar to that of option 2 of last year's assessment.

Final Cohort Analysis Run

The final cohort analysis run is given in Table 21 (a and b) along with the plots of all relationships examined in Figure 13.

This year's assessment is a much more pessimistic view of the stock than that given in O'Boyle (1981b). Compared to previous assessments (Table 22), the estimated sizes of the 1975-78 year-classes are all reduced. The 1979 year-class, as well as the 1980 year-class look strong.

This more pessimistic analysis is due to 2 factors:

1) Sampling during 1981 is much better than in previous years. Thus, the 1981 catch-at-age is more accurate than in previous years. This has been shown (Rivard and Doubleday 1979) to be very important in determining the current year's population size.

2) The discarding and misreporting of the 1977-79 period biased previous assessments upward. Now this problem is less prevalent. Consequently, the true, higher F values of the period are starting to emerge. This is influencing the choice of the current year's fishing mortality.

Yield-Per-Recruit and Projections

O'Boyle (1981b), determined that the $F_{0.1}$ value fluctuates around 0.3, which was chosen for the stock projections.

Projections to 1983 were run using the population parameters given in Table 23. The weights-at-age are those observed during 1981. All the other parameters were determined from the Sequential Population Analysis discussed earlier.

Assuming an $F_{0.1}$ catch of 27,000 t in 1982, the 1983 TAC would be 32,000 t (Table 24). If the catch in 1982 is the 32,000 t, as set by quota, then the 1983 TAC would be 30,000 t. Both these values are within 10% of the 1981 TAC and thus there appears to be no justification for a change in quota.

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Table 1. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding unit area 4Xs) by country.

YEAR	CANADA (Ma)	CANADA (Nfld)	USA	USSR	SPAIN	OTHER	TOTAL	QUOTA
1968	27279	-	2858	335	116	36	30624	-
1969	27413	-	1707	-	473	19	29612	-
1970	15560	-	1639	2	370	12	17583	18000
1971	16067	-	656	97	347	1	17168	18000
1972	12391	-	411	10	470	1	13283	9000
1973	12536	-	268	14	134	6	12958	9000
1974	12243	-	662	35	97	-	13037	-
1975	15991	-	2109	39	7	2	18148	15000
1976	16294	-	972	-	95	5	17366	15000
1977	19561	-	1649	2	-	12	21224	15000
1978	25300	114	1135	2	-	27	26578	21500
1979	24287	268	69	3	-	15	24642	26000
1980[1]	28215	75	256	-	-	34	28580	28000
1981[2]	30156	113	342	-	-	16	30627	27850

[1]Provisional 25/4/81

[2]Provisional 10/4/82

Table 2. Recent Canadian fishery allocations and the respective reported catch in metric tons for 4X haddock. (All information from Atlantic Quota Reports.)

Year	Vessel Size	Allocation	Reported Catch	% of Allocation
1975	all vessels	12500	15970	128
1976	all vessels	13300	15715	118
1977	all vessels	13400	20220	151
1978	all vessels	21500	25518	119
1979	>125 ft.	8500	6471	76
	<125 ft.	17500	17949	103
1980	>125 ft.	5500	5095	93
	<125 ft.	22500	23585	105
1981	>125 ft.	5500	5319	97
	<125 ft.	22350	23881	107
1982	<65 ft.	23850	3043[1]	(13)
	65-100 ft.	1100	354[1]	(32)
	>100 ft.	7050	1499[1]	(21)

[1]March 31, 1982 Atlantic Quota Report

( ) - to indicate these should not be compared with values for previous years.

Table 3.. Reported nominal catch (t round) of haddock from unit areas 4Xm-r for Canadian (Maritimes and Quebec) fishery by gear type.

( ) - number of samples taken by MFD.

Year	Otter Trawl Side & Stern	Longline	Miscellaneous Gears	Total
1968	24128(42)	1907	1244	27279
1969	23752(52)	2322	1339	27413
1970	11395(23)	2867	1298	15560
1971	12001(20)	3112(3)	954	16067
1972	7491(22)	3967(7)	933(1)	12391
1973	6050(16)	5785(9)	701	12536
1974	5572(9)	6162(10)	509(1)	12243
1975	10500(43)	4943(8)	548(1)	15991
1976	10492(35)	4637(6)	1165(2)	16294
1977	14530(70)	4035(8)	996	19561
1978	17305(49)	6049(10)	1946(4)	25300
1979	18504(35)	4348(12)	1435(2)	24287
1980	20095(34)	5717(17)	2403(4)	28215
1981	21246(49)	6995(26)	1915(7)	30156

Table 4. Reported nominal catches (t round) of haddock from unit areas 4Xm-r for Canadian otter trawl fishery by tonnage class.

( ) - number of samples taken by MFD.

	TONNAGE CLASS					
Year	0-25	26-50	51-150	151-500	500+	Total
1968	850	3537(6)	5904(5)	10560(34)	3275(2)	24126
1969	489	2037(3)	3755(6)	9695(36)	7776(10)	23752
1970	196(1)	1728(3)	2970(1)	3666(20)	2834(2)	11394
1971	174(1)	1511(3)	2604(2)	4752(12)	2960(5)	12001
1972	145	977(1)	1619(2)	2807(17)	1943(3)	7491
1973	105	786(5)	931(1)	2565(11)	1663(3)	6050
1974	208(1)	1914(2)	1827(2)	1069(5)	554	5572
1975	316(3)	2391(5)	3384(10)	2414(19)	1995(9)	10500
1976	310	1452(3)	2586(1)	3044(22)	3100(11)	10492
1977	456	2196(2)	3533(4)	3689(33)	4656(31)	14530
1978	930	3399	4884(1)	3860(35)	4233(13)	17305
1979	880	3693	5297(2)	4315(21)	4319(12)	18504
1980	2136	4417(6)	6102(4)	3660(13)	3780(11)	20095
1981	2021(1)	6415(20)	6163(21)	2837(4)	3810(3)	21246

Table 5. Reported nominal catch (t round) of 4X haddock from unit areas m-r for Canadian (MQ) otter trawl fishery.

UNIT AREA		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
TC 1-3	M	0	1	0	0	0	0	1	0	22	1	30	11	17	46
	N	48	614	300	192	138	31	4	154	314	390	805	1691	2774	3754
	O	1014	820	428	270	85	88	129	558	435	779	1604	1138	1934	2445
	P	1552	458	1616	1460	371	64	54	1126	329	1490	2592	1799	1087	1659
	Q	1143	437	455	490	544	435	632	1532	1131	1112	1903	2978	3698	3068
	R	6530	3950	2096	1877	1603	1203	3129	2324	2107	1423	2010	1950	2987	3278
	U	5	1	0	0	0	2	0	398	13	991	270	303	160	351
	TOTAL	10292	6281	4895	4289	2741	1823	3949	6092	4351	6186	9214	9870	12657	14601
TC 4-5	M	28	102	45	6	8	0	20	97	79	129	208	256	288	184
	N	4098	10242	2439	4040	1700	2595	471	2078	3931	4025	3818	4732	3729	4639
	O	1778	1681	950	1025	1397	1000	550	1576	1485	2349	1828	2658	2223	1382
	P	7341	5068	2826	2370	1296	480	341	576	541	1731	1585	793	1133	392
	Q	544	319	238	250	325	154	241	77	106	41	116	52	38	1
	R	47	59	2	21	24	0	0	3	4	0	0	0	0	0
	U	0	8	17	4	0	37	0	0	1	69	536	144	29	47
	TOTAL	13836	17479	6517	7716	4750	4266	1623	4407	6147	8344	8091	8635	7440	6645
TOTAL		24128	23760	11412	12005	7491	6089	5572	10499	10498	14530	17305	18505	20097	21246

Table 6. Reported nominal catch (t round) of 4X haddock from unit areas m-r and u (unknown) for Canadian otter trawls fishery (TC 4-5) by month and year.

YEAR	UNIT AREA	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1968	M	0	7	0	0	0	5	2	0	0	5	1	8	28
	N	332	790	1039	402	301	47	29	84	177	73	706	118	4098
	O	747	636	132	152	49	9	3	8	3	6	26	6	1777
	P	276	518	1226	1938	1048	808	319	401	218	286	138	163	7339
	Q	0	110	107	0	5	26	100	78	37	23	13	46	545
	R	6	0	0	0	3	0	1	0	3	2	17	15	47
	U	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	M	0	0	0	0	0	2	0	0	0	0	0	6	8
	N	178	514	210	171	91	333	28	29	28	49	67	10	1698
	O	344	386	194	57	125	157	23	22	19	44	17	8	1396
	P	108	249	56	0	0	424	142	182	64	40	24	7	1296
	Q	0	10	0	20	6	80	150	28	9	8	12	2	325
	R	0	0	0	0	0	14	0	10	0	0	0	0	24
	U	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	M	0	0	0	0	35	16	7	1	0	7	9	5	80
	N	219	752	980	26	626	492	507	147	51	79	21	30	3930
	O	200	148	185	8	43	141	140	67	130	105	224	93	1484
	P	7	25	51	0	54	251	113	13	20	5	1	1	541
	Q	0	0	0	6	0	32	40	7	1	0	4	16	106
	R	1	0	0	0	0	0	3	0	0	0	0	0	4
	U	0	0	1	0	0	0	0	0	0	0	0	0	1
1977	M	5	28	29	9	10	17	7	0	0	5	1	17	128
	N	378	970	793	388	363	164	38	91	93	301	427	19	4025
	O	274	474	260	145	201	174	26	127	50	155	436	25	2347
	P	293	204	92	21	0	669	23	32	0	229	154	15	1732
	Q	0	0	4	0	3	14	8	3	0	0	9	0	41
	R	0	0	0	0	0	0	0	0	0	0	0	0	0
	U	0	0	31	0	0	0	34	0	0	4	0	0	69
1978	M	0	5	71	8	59	63	2	0	0	0	0	0	208
	N	153	444	389	473	1157	525	279	39	5	0	7	347	3818
	O	398	123	266	43	57	143	108	13	0	0	17	659	1827
	P	152	61	32	0	3	648	361	124	3	2	1	199	1586
	Q	22	0	0	14	7	49	12	6	7	0	0	0	117
	R	0	0	0	0	0	0	0	0	0	0	0	0	0
	U	0	0	27	44	72	109	271	0	0	0	0	13	536
1979	M	15	21	28	22	6	0	3	0	3	35	46	77	256
	N	321	427	1734	404	195	12	16	43	191	214	384	791	4732
	O	880	108	53	36	45	4	2	18	83	286	344	799	2658
	P	67	238	101	0	0	51	114	22	42	32	32	94	793
	Q	0	0	16	8	0	12	13	0	3	0	0	0	52
	R	0	0	0	0	0	0	0	0	0	0	0	0	0
	U	0	30	41	7	0	3	0	0	0	0	0	63	144
1980	M	5	33	145	0	23	11	1	0	0	0	13	56	287
	N	605	979	635	167	179	98	130	41	41	275	154	425	3729
	O	194	190	43	3	11	8	33	23	89	257	723	648	2222
	P	8	312	103	0	0	68	57	3	33	116	27	405	1132
	Q	0	7	0	0	0	1	19	8	0	0	3	0	38
	R	0	0	0	0	0	0	0	0	0	0	0	0	0
	U	0	0	0	0	0	5	0	0	2	22	0	0	29
1981[1]	M	0	27	49	13	17	0	1	0	1	42	26	8	184
	N	198	1128	1435	1142	231	58	0	46	148	67	138	48	4639
	O	99	140	14	3	114	66	5	24	11	16	336	553	1381
	P	25	139	17	1	0	46	0	0	1	4	3	156	392
	Q	0	0	0	0	0	0	0	0	1	0	0	0	1
	R	0	0	0	0	0	0	0	0	0	0	0	0	0
	U	0	0	37	0	0	0	0	0	0	0	0	10	47

[1]Provisional

Table 7. Reported nominal catch (t round) of 4X haddock from unit area m-r for Canadian otter trawl fishery (TC 1-3) by month and year.

YEAR	UNIT AREA	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1968	M	0	0	0	0	0	0	0	0	0	0	0	0	0
	N	3	4	5	25	0	7	0	0	0	0	4	0	48
	O	61	35	106	293	244	92	84	56	26	12	7	0	1014
	P	4	13	223	948	268	20	33	1	7	27	5	3	1552
	Q	32	27	126	137	230	88	80	291	80	41	9	2	1143
	R	50	99	45	94	1041	1413	1122	1195	893	305	187	86	6530
	U	0	0	0	0	1	0	0	0	0	0	0	4	5
1972	M	0	0	0	0	0	0	0	0	0	0	0	0	0
	N	23	15	21	37	28	0	0	0	13	1	0	0	138
	O	3	18	4	6	0	26	9	13	6	0	0	0	85
	P	1	0	0	0	0	335	22	13	0	0	0	0	371
	Q	27	5	31	73	108	122	66	52	47	11	2	0	544
	R	24	5	6	18	285	304	276	233	250	143	42	17	1603
	U	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	M	0	0	9	0	3	0	2	4	3	1	0	0	22
	N	0	14	34	5	47	33	50	29	58	28	16	0	314
	O	0	20	51	17	28	42	40	32	108	44	47	6	435
	P	0	40	18	5	6	91	87	60	19	0	3	0	329
	Q	0	0	3	19	231	236	140	66	249	114	53	20	1131
	R	1	0	12	15	275	493	618	231	241	128	78	15	2107
	U	5	0	0	0	0	0	0	0	0	0	8	0	13
1977	M	0	0	0	0	0	0	0	0	1	0	0	0	1
	N	0	26	2	80	76	42	71	64	27	0	2	0	390
	O	1	411	92	50	63	24	25	52	40	11	8	0	777
	P	0	44	12	4	0	800	176	261	127	52	13	1	1490
	Q	0	0	5	53	121	263	185	165	219	86	15	0	1112
	R	1	0	1	27	161	189	166	243	174	348	111	2	1423
	U	1	22	23	33	61	235	132	105	115	132	122	10	991
1978	M	0	0	0	1	0	1	3	1	9	13	2	0	30
	N	58	61	15	296	282	37	33	9	13	0	0	0	804
	O	70	483	93	247	477	59	65	45	10	29	12	14	1604
	P	51	105	0	51	43	1569	419	305	25	9	15	0	2592
	Q	0	3	5	139	294	254	364	388	253	167	37	0	1904
	R	9	8	0	38	206	364	293	304	485	198	102	3	2010
	U	0	34	26	16	46	31	58	20	32	4	1	2	270
1979	M	0	0	0	2	4	2	3	0	0	0	0	0	11
	N	0	5	495	801	150	33	27	93	56	21	11	0	1692
	O	32	20	183	190	99	122	90	115	44	138	89	19	1141
	P	8	40	74	120	3	876	339	177	28	99	32	3	1799
	Q	0	0	22	48	663	592	417	480	390	321	39	6	2978
	R	0	2	0	40	418	340	205	290	318	179	149	9	1950
	U	0	0	0	29	2	12	53	31	92	84	0	0	303
1980	M	0	0	5	1	1	1	1	0	0	4	1	3	17
	N	8	268	495	1079	476	81	99	55	73	76	12	52	2774
	O	41	140	52	167	140	146	175	147	180	449	153	144	1934
	P	20	167	9	5	6	484	177	93	50	3	0	73	1087
	Q	2	40	55	114	599	607	664	608	584	297	70	58	3698
	R	15	9	2	21	462	625	534	493	389	348	77	12	2987
	U	0	0	7	17	3	11	5	2	39	59	15	2	160
1981 [1]	M	0	0	0	27	6	0	5	3	1	0	2	2	46
	N	272	775	1177	555	520	143	70	90	60	76	2	14	3754
	O	283	404	113	99	519	265	271	160	162	122	23	24	2445
	P	74	379	5	0	14	898	208	31	9	27	7	7	1659
	Q	0	4	12	70	320	431	580	480	921	232	9	9	3068
	R	5	11	6	92	374	419	614	589	493	596	60	19	3278
	U	6	11	23	16	71	25	39	72	71	11	6	0	351

[1] Provisional

Table 8.

A. CATCH AT AGE (NUMBERS IN 000) OF HADDOCK CAUGHT IN UNIT AREAS 4XN-4XR, EXCLUDING DISCARDS

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0	0	0	0	0	0	0	0	0	0	41	150	1	37	18	2	0	0	18	2
2	139	713	155	70	219	22	665	10	1055	788	22	3077	694	2175	1296	1285	75	91	155	1143
3	4524	2013	1272	3038	18341	515	297	2016	724	1617	3434	113	4653	4568	1644	3126	3354	1158	2305	2176
4	1415	7185	4286	1981	9796	20380	1164	1968	1502	798	1841	2247	309	5164	4261	2019	7014	6709	2997	6177
5	1779	3087	9337	3153	3167	9148	17448	1621	379	1422	509	1067	1779	485	3682	3193	2094	3881	5430	4190
6	1708	1649	3018	5409	2149	1039	4684	11243	524	404	645	527	509	1103	434	2981	2932	1070	3538	3190
7	1643	1415	1492	1973	3747	735	713	3220	4536	69	90	600	189	247	807	360	1040	1244	505	1169
8	973	593	1370	1000	840	1052	518	455	1863	3316	57	322	269	172	154	389	137	263	625	373
9	645	478	612	745	409	187	672	249	133	1020	1166	259	186	62	71	107	107	57	170	327
10	232	152	416	298	424	102	190	194	96	163	512	614	269	32	95	72	26	68	33	97
11	205	113	297	203	88	90	131	172	175	181	26	55	552	165	39	23	9	11	22	14
12	84	59	168	114	62	23	65	94	27	146	193	13	24	229	103	3	6	0	4	22
13	100	43	36	113	84	81	89	69	37	105	92	6	4	11	157	87	48	18	16	11

B. MEAN WEIGHTS AT AGE (KG) OF HADDOCK CAUGHT IN UNIT AREAS 4XN-4XR

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.27	0.18	0.23	0.23	0.28	0.29	0.29	0.15	0.23
2	0.56	0.50	0.50	0.36	0.31	0.32	0.37	0.56	0.57	0.50	0.45	0.51	0.46	0.52	0.52	0.46	0.44	0.51	0.52	0.59
3	0.75	0.78	0.75	0.65	0.67	0.62	0.62	0.75	0.90	0.96	0.90	0.75	0.82	0.82	0.81	0.71	0.87	0.87	0.88	0.88
4	1.15	1.05	1.00	1.00	0.85	0.85	0.90	0.88	1.05	1.25	1.35	1.25	1.10	1.20	1.19	1.22	1.33	1.33	1.33	1.26
5	1.40	1.45	1.30	1.20	1.23	1.05	1.10	1.15	1.16	1.40	1.60	1.80	1.70	1.55	1.60	1.72	1.85	1.84	1.78	1.72
6	1.60	1.70	1.70	1.56	1.50	1.45	1.30	1.35	1.43	1.50	1.75	2.00	2.30	2.25	2.10	2.20	2.33	2.36	2.36	2.22
7	2.20	1.85	1.95	1.95	1.80	1.80	1.70	1.60	1.65	1.75	1.90	2.20	2.50	2.85	2.95	2.94	2.70	2.83	2.90	2.55
8	2.12	2.35	2.04	2.20	2.18	2.05	2.05	2.00	1.95	1.95	2.10	2.30	2.60	3.00	3.50	3.30	3.39	3.30	3.28	3.15
9	1.90	2.25	2.50	2.30	2.50	2.36	2.30	2.45	2.30	2.30	2.30	2.50	2.80	3.20	3.60	3.57	3.77	4.03	3.82	3.65
10	2.40	2.20	2.40	2.63	2.50	2.70	2.52	2.50	2.82	2.65	2.80	2.70	2.95	3.45	3.80	3.77	4.17	4.15	4.34	3.70
11	2.86	2.70	2.42	2.50	2.75	2.70	3.00	2.70	2.80	3.25	3.00	3.30	3.20	3.50	4.10	3.69	4.03	4.96	4.21	4.31
12	2.70	3.20	3.00	2.70	2.60	2.89	2.90	3.30	2.85	3.00	3.70	3.40	3.80	3.70	4.00	3.94	3.62	6.00	4.84	4.83
13	3.99	3.25	3.61	3.30	3.00	2.80	2.95	3.06	3.60	3.00	3.30	4.20	3.90	4.40	4.20	3.91	4.63	5.68	4.97	4.72

Table 9.

A. PERCENT COMPOSITION (BY NUMBERS) OF HADDOCK CAUGHT IN UNIT AREAS 4XM-4XR, EXCLUDING DISCARDS

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.7	0.0	0.3	0.1	0.0	0.0	0.0	0.1	0.0
2	1.0	4.1	0.7	0.4	0.6	0.1	2.5	0.0	9.5	7.9	0.3	34.0	7.4	15.1	10.2	9.5	0.4	0.6	1.0	5.1
3	33.7	11.5	5.7	16.8	46.6	1.5	1.1	9.5	6.6	16.1	39.8	1.2	49.3	31.6	12.9	23.1	20.0	8.0	14.6	11.5
4	10.5	41.1	19.1	11.0	24.9	61.1	4.4	9.2	13.6	7.9	21.3	24.8	3.3	35.7	33.4	14.9	41.9	46.1	18.9	32.7
5	13.2	17.6	41.6	17.4	9.1	27.4	85.5	7.6	3.4	14.2	5.9	11.8	18.8	3.4	28.9	23.6	12.5	26.7	34.3	22.1
6	12.7	9.4	13.4	29.9	5.5	3.1	17.6	52.8	4.7	4.0	7.5	5.8	5.4	7.6	3.4	21.3	16.9	7.3	22.4	16.9
7	12.3	8.1	6.6	10.9	9.5	2.2	2.7	15.1	41.0	0.7	1.0	6.6	2.0	1.7	6.3	2.7	9.2	8.5	3.2	5.2
8	7.2	3.4	6.1	5.5	2.1	3.2	1.9	2.1	16.9	33.1	0.7	3.6	2.9	1.2	1.2	2.9	0.8	1.8	4.0	2.0
9	4.8	2.7	2.7	4.1	1.0	0.6	2.5	1.2	1.2	10.2	13.5	2.9	2.0	0.4	0.6	0.8	0.6	0.4	1.1	1.7
10	1.7	0.9	1.9	1.6	1.1	0.3	0.7	0.9	0.9	1.6	5.9	6.8	2.9	0.2	0.7	0.5	0.2	0.5	0.2	0.5
11	1.5	0.6	1.3	1.1	0.2	0.3	0.5	0.8	1.6	1.8	0.3	0.6	5.8	1.1	0.3	0.2	0.1	0.1	0.1	0.1
12	0.5	0.3	0.7	0.6	0.2	0.1	0.2	0.4	0.2	1.5	2.2	0.1	0.3	1.6	0.8	0.1	0.0	0.0	0.0	0.1
13	0.7	0.2	0.2	0.6	0.2	0.2	0.3	0.3	0.3	1.0	1.1	0.1	0.0	0.1	1.2	0.6	0.3	0.1	0.1	0.1

B. PERCENT COMPOSITION (BY WEIGHT) OF HADDOCK CAUGHT IN UNIT AREAS 4XM-4XR, EXCLUDING DISCARDS

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.4	1.6	0.2	0.1	0.2	0.0	0.8	0.0	3.7	2.4	0.1	13.0	2.5	6.5	3.6	2.9	0.1	0.2	0.3	2.0
3	17.9	6.9	3.0	7.6	31.4	1.0	0.6	5.3	4.0	9.6	23.7	0.7	29.3	21.6	7.1	10.8	10.8	4.1	7.1	5.2
4	8.6	33.1	13.3	7.6	21.3	51.7	3.3	6.1	9.6	6.1	19.1	23.2	2.6	35.8	27.2	12.0	34.9	36.1	13.9	25.4
5	13.1	19.6	37.7	14.6	10.0	28.7	80.2	6.6	2.7	12.3	6.2	15.9	23.2	4.3	31.6	26.7	14.5	29.0	33.8	23.4
6	14.4	12.3	15.9	32.6	8.2	4.5	19.1	53.4	4.6	3.7	8.7	8.7	9.0	14.3	4.9	30.8	24.6	10.2	29.2	23.1
7	19.1	11.5	9.0	14.8	17.2	3.9	3.8	18.1	45.6	0.7	1.3	10.9	3.6	4.1	12.8	5.1	10.5	14.3	5.1	10.1
8	10.9	6.1	8.7	8.5	4.7	5.4	3.3	3.2	22.1	39.8	0.9	6.1	5.4	3.0	2.9	6.2	1.7	3.5	7.2	3.8
9	6.5	4.7	4.8	6.6	2.6	1.3	4.8	2.1	1.9	14.5	20.6	5.4	4.0	1.1	1.4	1.9	1.5	0.9	2.3	3.9
10	2.9	1.5	3.1	2.9	2.7	0.8	1.5	1.7	1.6	2.7	11.9	13.7	6.1	0.6	1.9	1.3	0.4	1.1	0.5	1.2
11	3.1	1.3	2.2	3.0	0.6	0.7	1.2	1.6	3.0	3.6	0.6	1.5	13.6	3.3	0.9	0.4	0.1	0.2	0.3	0.2
12	0.9	0.8	1.6	1.2	0.4	0.2	0.6	1.1	0.5	2.7	5.5	0.4	0.7	4.9	2.2	0.2	0.1	0.0	0.1	0.3
13	2.1	0.6	0.4	1.4	0.6	0.7	0.8	0.7	0.8	1.9	2.3	0.2	0.1	0.3	3.5	1.7	0.8	0.4	0.3	0.2

Table 10. Stratified mean catch (in numbers) per standard tow of haddock caught during Canadian Summer Bottom Trawl Survey (Strata 70-91, 95)

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	-	-	-	-	-	-	-	0.007	-	0.352	0.024	0.51
1	4.872	0.099	4.404	4.976	8.153	5.518	4.617	5.278	5.391	1.636	18.511	30.86[1]
2	3.921	9.263	0.195	19.053	17.942	3.466	5.272	20.246	4.660	11.528	6.028	23.78
3	1.148	3.933	2.732	0.479	21.220	4.383	3.394	13.077	9.544	6.605	13.179	5.86
4	2.167	1.729	1.160	2.466	0.768	6.013	3.405	3.868	2.870	7.919	6.841	7.32
5	0.881	2.489	0.761	1.131	3.578	0.394	6.175	5.557	1.400	4.009	10.472	2.77
6	1.982	1.131	0.825	0.423	0.775	1.417	0.467	3.456	2.615	1.605	3.527	3.04
7	5.073	1.746	0.543	0.569	0.438	0.510	0.553	0.466	0.988	2.524	1.298	1.03
8	0.704	4.424	0.808	0.429	0.505	0.287	0.101	0.558	0.025	0.949	1.056	0.21
9	0.293	0.504	1.106	0.287	0.268	0.136	0.026	0.121	-	0.208	0.510	0.37
10	0.258	0.078	0.037	0.371	0.202	0.043	0.033	0.095	-	0.026	0.202	0.24
11	0.069	0.035	0.005	0.018	0.287	0.246	0.008	0.008	0.035	-	0.031	0.12
12	0.017	0.053	0.004	0.008	-	0.153	0.284	0.216	0.130	0.099	-	0.04
NK	-	-	0.066	-	-	-	0.074	0.007	0.088	0.121	-	0.01
TOTAL	21.385	25.484	12.646	30.210	54.136	22.566	24.409	52.960	27.746	37.581	61.679	76.16
2+	16.513	25.385	8.242	25.234	45.983	17.048	19.792	47.675	22.355	35.593	43.144	44.79
5+	9.277	10.460	4.155	3.236	6.053	3.186	7.721	10.484	5.281	9.541	17.096	7.83
TOTAL kg/tow	22.95	27.50	13.24	12.77	39.46	21.29	22.21	90.45	26.46	41.98	57.10	44.68

[1] Includes set 66 (Stratum 90) without this set the Age 1 estimate is 11.74 and the total estimate is 57.03.

Table 11. Strata ranking of haddock catches (numbers per tow) from Canadian Summer Bottom Trawl Survey. 1 - highest catch rate; 2 - second highest catch rate . . . . . 5 - fifth highest catch rate.

STRATA	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
70	-	-	-	-	-	-	-	2	-	-	-	-
71	-	-	-	-	-	-	-	-	-	-	-	-
72	-	-	-	-	-	4	-	-	-	-	2	2
73	2	-	2	4	-	-	2	3	-	5	-	-
74	5	-	4	-	4	2	4	-	2	2	-	4
75	3	4	-	5	3	-	1	-	4	-	5	-
76	-	2	-	-	5	3	-	-	-	-	-	-
77	-	5	5	-	-	-	5	-	-	-	-	5
78	-	-	-	-	-	-	-	-	-	-	-	-
79	-	-	-	-	-	-	-	-	-	-	-	-
80	1	1	1	2	2	1	-	1	1	3	3	3
81	4	-	3	1	1	-	-	-	3	4	4	-
82	-	-	-	-	-	-	-	-	-	-	-	-
83	-	-	-	-	-	-	-	-	-	-	-	-
84	-	-	-	-	-	-	-	-	-	-	-	-
85	-	-	-	-	-	-	-	-	-	-	-	-
90	-	3	-	3	-	5	3	5	5	1	1	1
91	-	-	-	-	-	-	-	4	-	-	-	-
92	-	-	-	-	-	-	-	-	-	-	-	-
93	-	-	-	-	-	-	-	-	-	-	-	-
94	-	-	-	-	-	-	-	-	-	-	-	-
95	-	-	-	-	-	-	-	-	-	-	-	-

Table 12. Percent of Canadian Summer Survey Abundance Estimates age 4 and under.

STRATA	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	$\bar{x}$ 1970-81	$\bar{x}$ 1977-81
70-73	19.5	64.5	50.3	37.5	68.2	52.3	47.6	59.8	65.5	52.5	49.1	55.5	51.9	56.5
74-78	66.9	38.3	54.7	85.2	82.6	47.9	53.0	73.6	86.7	43.5	55.5	68.5	63.0	65.6
80-83	53.1	65.0	68.4	88.6	91.7	70.0	55.2	87.0	72.1	45.0	71.0	54.4	68.5	65.9
84-95	5.9	36.0	17.7	64.6	93.3	39.2	59.2	61.2	55.0	65.2	59.8	93.1	54.2	66.9

Table 13. Analysis of variation present in Canadian Summer Bottom Trawl Survey.

Year	Strata Contributing Most To Survey Estimate	% Contribution To Abundance Estimate	% Contribution To Overall Variance	No. Sets
1970	81	26.7	30.1	5
	85	18.6	54.0	2
		45.3	84.1	7
1971	76	23.69	50.9	2
	80	31.47	25.5	4
		55.16	76.4	6
1972	80	26.09	45.98	4
	81	23.72	38.31	4
		49.81	84.29	8
1973	81	56.27	84.31	4
1974	81	40.87	61.35	4
	90	15.41	22.08	2
		56.28	83.43	6
1975	72	13.74	39.00	2
	76	17.73	>1	6
	80	26.15	14.57	3
	81	16.84	38.15	4
		74.46	91.72	15
1976	77	19.20	34.87	2
	81	24.64	7.77	4
	90	15.22	11.43	3
		59.06	54.07	9
1977	76	45.75	84.66	4 (one tow primarily)
1978	80	24.34	35.97	3
	81	31.35	62.48	4
		55.69	98.45	7
1979	81	21.22	71.63	4
	90	30.32	6.57	2
		51.54	78.20	6
1980	72	25.93	43.85	2
	81	25.93	41.42	3
		51.86	85.27	5
1981	72	15.7	4.40	2
	90	59.1	93.64	3
		74.8	98.04	5

Table 14. Stratified mean catch (in numbers) per standard tow of haddock caught during U.S. Fall Bottom Trawl Survey (Strata 31-34)

AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	79.39	0.21	1.53	1.14	0.13	3.55	10.27	0.13	20.46	7.74	1.12	3.70	7.10	11.74	12.55	6.08	25.24	55.57	6.31
1	48.68	14.21	2.46	1.83	6.29	1.72	4.66	4.88	0.06	34.03	3.85	2.77	4.42	13.66	16.16	9.85	12.05	42.83	47.82
2	15.67	10.96	24.99	2.88	2.44	4.60	0.52	2.51	8.61	0.12	16.12	6.72	2.91	4.43	29.46	11.93	28.85	8.73	-
3	14.03	3.58	10.67	39.85	3.89	1.62	2.17	0.41	2.30	5.32	0.21	7.54	1.96	1.92	13.33	14.45	8.47	5.52	-
4	19.62	4.62	3.67	12.82	31.64	0.49	0.32	1.16	0.31	1.54	1.95	-	5.07	2.38	3.99	5.61	8.38	2.37	-
5	7.64	7.37	2.95	4.08	4.57	12.83	0.04	0.25	1.07	0.18	0.35	0.87	-	3.66	4.27	2.43	2.84	1.95	-
6	3.29	2.18	3.99	2.30	0.98	4.13	3.09	0.81	0.16	0.60	0.16	0.36	0.35	-	6.02	3.14	1.52	0.47	-
7	1.52	0.63	1.24	3.80	1.07	0.53	1.42	3.09	0.11	0.17	0.16	0.13	0.23	0.58	0.14	0.43	0.60	0.19	-
8	1.21	0.75	0.19	1.55	0.47	0.73	0.17	1.29	3.70	0.14	0.08	0.14	0.14	0.02	0.09	-	0.04	0.35	-
9	0.33	0.34	0.37	0.09	0.17	0.71	0.62	0.34	1.54	1.83	0.30	0.07	0.12	-	0.10	0.12	-	0.11	-
10	0.42	0.042	-	-	-	-	0.36	0.34	0.28	0.36	1.07	0.07	-	0.02	-	0.07	-	-	-
11	0.05	-	-	-	-	-	0.10	0.16	0.41	-	0.12	2.02	0.03	-	0.09	-	-	-	-
12	0.08	-	-	-	-	-	-	0.06	-	0.20	-	0.27	0.05	0.25	-	-	-	-	-
13	-	-	-	-	-	-	-	0.05	-	-	-	-	0.04	0.03	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	0.12	-	-	0.10	0.05	-	-	-
TOTAL	191.92	44.89	52.07	71.15	51.63	30.92	23.74	15.48	39.01	52.22	25.49	24.78	22.42	38.69	86.30	54.18	87.99	118.09	96.06
AGES 2+	63.86	30.47	48.07	68.18	45.23	25.64	8.81	10.47	18.49	10.46	20.47	18.31	10.90	13.29	57.59	38.23	50.70	19.69	41.93
AGES 5+	14.54	11.31	8.74	12.63	7.26	18.93	5.80	6.39	7.27	3.48	2.24	4.05	0.96	4.56	10.81	6.24	5.00	3.07	-
TOTAL kg/tow	67.91	31.43	31.82	58.65	34.91	28.53	14.59	17.66	24.10	24.45	17.27	20.74	13.86	21.94	75.29	53.59	55.55	33.47	56.57

Table 15. Catch rates (numbers per tow) of age 0-3 4X haddock caught in Canadian groundfish surveys of 1979-1981(Strata 70-85 only).

	1979			1980			1981		
AGE	MARCH	JULY	OCT. - NOV.	MARCH	JULY	OCT. - NOV.	MARCH	JULY	OCT. - NOV.
0	0	0.40	13.27	0	0.03	112.80	NOT AVAILABLE	0.57	NOT AVAILABLE
1	1.25	1.58	6.61	5.73	20.19	21.15		13.05	
2	17.03	7.00	20.78	2.14	3.41	5.99		3.68	
3	19.27	3.27	6.18	16.24	9.41	10.96		1.17	

Table 16. Research and commercial abundance indices of the 4X haddock stock.

	RESEARCH SURVEYS				COMMERCIAL STATISTICS	
	Canadian Summer Strata 70-91, 95 (3 year median smooth)		U.S. Fall Strata 31-34 (3 year median smooth)		Stern Otter Trawlers T.C. 2+3 May-August 4Xq-r (3 year median smooth)	T.C. 4+5 Jan-March 4Xn (3 year median smooth)
Year	No./Tow	KG/Tow	No./Tow	KG/Tow	t/trip	t/Days on Ground
1963	-	-	52.07	31.82	-	-
1964	-	-	52.07	31.82	-	-
1965	-	-	52.07	31.82	-	-
1966	-	-	52.07	34.91	-	-
1967	-	-	51.63	34.91	-	-
1968	-	-	30.92	28.53	3.09	9.62
1969	-	-	23.74	17.66	2.83	8.68
1970	25.48	27.50	23.74	17.66	2.70	6.05
1971	25.48	22.95	39.01	24.10	2.30	4.51
1972	25.48	13.24	39.01	24.10	2.30	4.51
1973	30.21	13.24	25.49	20.74	2.30	4.43
1974	30.21	21.29	24.78	20.74	2.30	4.43
1975	24.41	22.21	24.78	20.74	2.31	4.43
1976	24.41	22.21	38.69	21.94	4.80	5.46
1977	27.75	26.46	54.18	53.59	5.10	6.42
1978	37.58	41.98	86.30	53.59	5.10	6.42
1979	37.58	41.98	87.99	53.59	5.10	9.58
1980	57.03	44.68	96.06	53.59	4.54	9.58
1981	61.68	50.08.	112.2	53.59	4.49	9.58

Table 17. Mean and standard error of the mean for residuals grouped by year in a regression of length on age assuming constant growth parameters.

Year	Mean Residual	Standard Error	n
1977	0.536	0.189	489
1978	0.526	0.233	378
1979	-0.020	0.197	621
1980	-0.397	0.179	550
1981	-0.485	0.191	474
groups combined	-0.000	0.089	2512

Table 18 A. Final survivor run on 4Xm-r Haddock for 1970-81 period. Insert includes beginning of year population estimates (Column A) with fishing mortalities (Column B) by age and year.

INTEGRATED CATCH 1/ 5/82

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	3957	6596	12085	3130	22560	22030	10558	25088	23908	10522	8769	1144
4	5188	2553	3828	7346	2367	14010	14043	6976	15857	14938	6690	3248
5	1416	2924	1509	1834	4201	1574	7495	8143	3846	8116	6758	2199
6	445	804	1475	765	800	2149	873	3180	3945	1738	3291	1677
7	6442	106	441	645	310	318	900	357	869	1419	722	615
8	980	1744	30	169	141	90	81	205	72	138	329	196

FINAL ITERATION (1)

INTEGRATED SURVIVORS 1/ 5/82

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	927	488	1470	8	4232	4567	883	3512	10855	9037	31187	21117
4	1305	759	399	1203	6	3465	3739	723	2876	8888	7398	25534
5	1179	1068	622	327	985	5	2837	3061	592	2354	7277	6057
6	3103	966	874	509	268	807	4	2323	2506	484	1928	5958
7	6560	2540	791	716	417	219	660	3	1902	2052	397	1578
8	499	5371	2080	647	586	341	179	541	3	1557	1680	325

POPULATION NUMBERS 1/ 5/82

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	4884	7084	13554	3138	26792	26597	11441	28600	34763	19558	39957	22262
4	6493	3312	4228	8550	2373	17475	17782	7598	18733	23826	14088	28792
5	2595	3992	2130	2161	5186	1579	10332	11205	4437	10471	14035	8255
6	3548	1769	2350	1274	1068	2955	878	5503	6451	2222	5218	7635
7	13002	2647	1232	1361	727	538	1561	360	2770	3471	1118	2193
8	1479	7114	2110	817	728	432	260	745	75	1695	2009	521

ESTIMATED SURVIVORS 1/ 5/82

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	135	2778	0	0	19326	0	778	9999	6134	8838	30596	19109
4	968	1417	91	515	128	2842	0	2656	0	7715	12744	20194
5	361	1554	170	455	2235	0	3736	2667	0	991	13861	4107
6	2256	954	157	75	502	503	65	2475	940	991	3052	4262
7	3124	2639	518	408	452	558	194	461	894	2878	1486	1402
8	452	6833	1509	662	832	464	119	876	0	1679	1710	222

ESTIMATED VARIANCE OF SURVIVORS

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	690565	8105293	3910949	120224	235945428	10066158	6035934	133676433	106222680	75896165	430282327
4	3102190	1974879	988928	4017323	389648	23885425	7659224	9883790	8117684	92199132	97980519
5	370905	2960468	276745	611274	6117743	74183	18221516	14756772	936627	11457780	111327
6	2090220	680628	362153	95206	319586	1068377	116043	6355244	3638548	1370676	94
7	19499743	2309871	223408	245315	145361	197079	231712	164540	739628	4827006	13
8	560225	22123162	737972	208033	288270	93107	11531	351954	706	1018004	12

I	1981
3	126911687
4	167355700
5	11620374
6	10446339
7	1199199
8	49849

WEIGHTED SURVIVORS 1/ 5/82

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	6	4	0	0	32	0	6	65	462	1064	3568	19109
4	28	21	1	15	0	46	0	12	0	670	1189	14529
5	72	48	18	8	42	0	79	115	0	75	996	3229
6	476	104	39	23	16	54	0	150	164	32	280	3264
7	1660	504	173	152	92	39	95	2	466	379	51	1010
8	452	3201	902	237	263	148	105	284	0	636	863	194

RMS=0.2978448716

Table 18 B.

ESTIMATED SURVIVORS FOR AGE 8 (WEIGHTED)

YEAR	SURVIVORS	VARIANCE	STANDARD ERROR	C.V.(8/8)
1970	452	569225	748	165.60
1971	4861	10364389	3219	66.22
1972	1883	441227	664	35.28
1973	586	74358	273	46.55
1974	531	91185	302	56.71
1975	309	29681	172	55.79
1976	162	10224	101	62.24
1977	490	114142	338	69.02
1978	3	688	26	1032.38
1979	1409	385701	621	44.07
1980	1521	635726	797	52.43
1981	294	43653	209	71.08

ESTIMATED SURVIVORS FOR 1981 (WEIGHTED)

AGE	SURVIVORS	VARIANCE	STANDARD ERROR	C.V.(8/8)
3	19109	126911687	11266	58.95
4	23107	120491329	10977	47.50
5	5482	9137614	3023	55.14
6	5392	8001914	2829	52.46
7	1429	863611	929	65.05
8	294	43653	209	71.08

INSERT

		A	B
Age	3	25737	0.0973
	4	35014	0.2156
	5	11268	0.5205
	6	10081	0.4257
	7	3023	0.5496
	8	765	0.7571
Year	1970	2558	1.5333
	1971	9568	0.4773
	1972	2362	0.0270
	1973	1068	0.4009
	1974	943	0.3751
	1975	566	0.4053
	1976	367	0.6139
	1977	1023	0.5374
	1978	147	3.8559
	1979	2011	0.1554
	1980	2543	0.3143
	1981	765	0.7571

FINAL ESTIMATION FOR E

AGE	E	LN(E)	VAR(LN(E))	STANDARD ERROR	D.F
3	3799.21	8.1007	0.2836	0.1684	3
4	3492.60	8.0875	0.1418	0.1191	4
5	2432.04	7.7396	0.1137	0.1066	4
6	2101.11	7.5225	0.2554	0.1130	19
7	2101.11	7.5225	0.2554	0.1130	19
8	2101.11	7.5225	0.2554	0.1130	19

RESIDUALS 1/ 5/82

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	-0.1132	0.7464	-0.2669	-0.5447	1.1016	-0.4683	0.1196	0.5522	0.0421	0.2492	0.2256	0.0001
4	0.1533	0.6006	-0.0426	0.0073	0.1225	0.1838	-0.4023	0.5624	-0.6253	0.1491	0.5282	-0.1185
5	-0.1916	0.4162	-0.1407	0.2413	0.5176	-0.4995	0.3740	0.1875	-0.2648	-0.0713	0.5959	-0.2033
6	0.1602	0.2950	-0.3042	-0.3603	0.4220	0.0074	0.1116	0.2773	-0.1606	0.4171	0.3507	-0.1784
7	-0.1987	0.3265	-0.0767	-0.1293	0.2364	0.6899	-0.2951	0.9996	-0.2836	0.4239	0.8913	-0.0132
8	0.0003	0.2674	-0.2174	0.0988	0.3772	0.3344	-0.2049	0.4531	-0.3541	0.1623	0.0995	-0.1659

MEAN OF RESIDUALS=0.1151879266
STANDARD DEVIATION OF RESIDUALS=0.3670954214

OUTLIERS OF RESIDUALS 1/ 5/82

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	0.00	0.00	0.00	0.00	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.63	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.89	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 19. Correlation Coefficients of Relationships used to obtain fully recruited fishing mortality in 1981. Asterisks indicate relationshps given the most weight in the decision of choosing F_R.

1981 F	2+3 SPA VS 2+3 Research No./Tow	2-5 SPA VS 2-5 Research No./Tow *	6+ SPA VS 6+ Research No./Tow *	2-4 Pop. Biomass VS OT 2+3 CPUE	4+ Pop. Biomass VS OT 4+5 CPUE *
0.30	0.83	0.84	0.84	0.62	0.93
0.35	0.87	0.83	0.87	0.63	0.95
0.40	0.89	0.85	0.87	0.66	0.95
0.45	0.92	0.81	0.86	0.65	0.96
0.50	0.93	0.79	0.85	0.66	0.95

Note: Partial Recruitment for all these runs was the final one chosen during 1981 assessment (O'Boyle, 1981). i.e.

Age:	1	2	3	4	5	6	7	8	9	10	11	12
PR:	0.0003	0.017	0.2	0.6	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 20. Correlation Coefficients of Relationships used to obtain 1981 partial recruitment estimates.

AGE	COMBINATIONS USED								
	A	B	C	D	E	F	G	Survivor	Last Year's
1	0.00006	0.00006	0.0003	0.0001	0.0003	0.0003	0.0003	0.0003	0.0003
2	0.04	0.03	0.04	0.03	0.05	0.04	0.04	0.02	0.017
3	0.3	0.2	0.4	0.2	0.35	0.4	0.2	0.2	0.2
4	0.6	0.6	0.6	0.6	0.7	1	0.6	0.44	0.6
5	1	1	1	1	1	1	1	1	0.8
6	1	1	1	1	1	1	1	1	1
	Correlation Coefficients								
2+3 SPA	0.95	0.92	0.95	0.92	0.95	0.91	0.92	0.94	0.89
2-5 SPA	0.76	0.82	0.73	0.82	0.69	0.66	0.80	0.82	0.85
6+ SPA	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.86	0.87
2-4 Bio	0.77	0.73	0.78	0.73	0.79	0.78	0.76	0.67	0.66
4+ Bio	0.96	0.96	0.96	0.96	0.93	0.96	0.96	0.95	0.95
1+2 SPA	0.91	0.91	-	0.83	-	-	-	-	-

Table 21 A. Final Cohort Analysis runs for 1981 4X Haddock Assessment.

POPULATION NUMBERS

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	24976	91667	201779	16480	12122	17387	8047	14510	25524	6144	42857	46326	24960	54144	42978
2	26882	20449	75020	164581	13456	9271	14244	6005	11880	20697	5032	39145	37793	20434	44298
3	60477	30071	16097	61306	134624	10983	6752	11060	5398	8772	16396	4100	29265	30314	14762
4	19224	45421	22799	15028	47444	93674	8526	5259	7231	3765	5718	10317	3255	19750	20686
5	11657	14468	30686	14788	8053	29980	58254	5927	2525	4561	2369	3016	6414	2385	11497
6	9556	7931	9922	16475	9524	3729	16268	31904	3384	1725	2448	1479	1504	3441	1514
7	4702	6361	5002	4680	9758	5432	2113	9081	15950	2298	1046	1420	734	771	1983
8	3256	3359	3927	2745	3547	3780	3946	1085	4521	8954	1819	775	620	430	408
9	1959	1745	1395	1976	1343	916	2143	2762	477	2016	4331	1438	343	264	197
10	1104	1020	996	588	944	729	580	1146	2036	270	728	2491	943	113	160
11	526	694	498	439	221	389	505	303	763	1580	74	132	1484	528	63
12	216	245	466	303	176	101	237	295	93	446	1130	37	59	715	283
1+	174592	222429	367186	296788	236484	175582	121634	89940	79784	61451	88948	110676	107372	133493	158830
2+	149616	130763	166167	280108	226581	158185	113567	75430	54260	55384	41091	64350	82412	79346	95852
3+	112734	110314	91116	115527	212925	149914	99324	68825	42380	34407	36059	25205	44620	58912	51554
4+	52257	80243	75019	54222	78241	138931	92572	57765	36982	25635	19663	21105	15355	28598	36791

	1977	1978	1979	1980	1981
1	38975	61878	31820	97034	91845
2	51546	31969	50661	26052	79430
3	35095	41040	26057	41405	21189
4	10599	25995	30566	20286	31814
5	13081	6851	14863	18954	13897
6	6081	9320	3714	8657	10605
7	847	2372	3840	2073	3886
8	894	368	1001	2019	1240
9	194	380	177	582	1087
10	77	62	214	93	322
11	45	14	27	114	47
12	17	16	3	13	73
1+	157471	178614	162943	217282	255536
2+	118496	116736	131124	120246	163591
3+	66949	84828	80462	94194	84161
4+	31854	43788	54406	52790	62971

MEAN POPULATION BIOMASS (KG)

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	6545	24094	52836	4384	2655	4573	2120	3814	6709	1616	12573	11317	6072	11283	13126
2	18682	9093	33973	53688	3804	2395	4456	1549	5041	9278	2048	17322	15601	9071	20549
3	37442	20488	10473	35151	74671	6815	3704	6258	4079	4851	11811	2746	17841	20457	10178
4	19749	39452	18505	9409	32139	63382	6433	3279	6884	3767	5703	10264	3077	18384	19747
5	13542	16746	29865	14167	6910	23551	48143	5219	2435	4754	3023	3911	8326	2971	13606
6	12631	10902	11267	19180	10941	4126	16026	31068	4014	2036	3383	2127	2523	6140	2411
7	7473	9336	7334	6309	10824	8531	2422	10461	19223	3584	1718	2124	1422	1424	4032
8	5092	4312	5795	4314	5065	5913	6884	1679	6949	12412	3464	1220	1085	895	1067
9	2734	3005	2335	3212	2512	1735	3644	5833	836	2908	7650	2932	580	645	507
10	2119	1868	1632	984	1564	1647	1076	2355	5072	400	978	5248	2111	296	345
11	1052	1545	1145	719	422	828	1171	629	1687	4343	138	277	3320	1376	143
12	441	515	1064	586	330	232	527	721	200	1043	3433	90	150	1911	813
1+	129022	141355	176163	152499	150878	122929	96946	74817	62999	53013	55802	59601	62161	75246	86466
2+	122457	117261	123327	148115	148222	118354	94826	71003	56291	51377	43229	48284	56089	63963	73340
3+	103775	108168	89354	94427	144418	115960	90369	69455	50450	42119	41182	30962	42488	54892	52790
4+	84333	87680	78881	59275	68748	109945	86465	66996	44370	35248	29371	28216	22647	34233	42612

	1977	1978	1979	1980	1981
1	7891	16264	8364	13191	19167
2	21203	12767	23516	12239	42148
3	21490	30791	20133	32031	15957
4	10478	24499	32254	27444	32429
5	17589	9492	21147	25593	17974
6	3668	13026	6641	14058	17704
7	1688	4298	9812	4701	7745
8	1791	883	2552	4937	2937
9	414	1089	526	1679	2984
10	161	177	658	292	997
11	104	30	94	387	158
12	42	42	15	45	266
1+	93711	115346	123912	131616	160366
2+	83820	99082	115549	118425	141200
3+	62617	86315	92032	106185	99052
4+	41127	55524	71900	74154	83094

Table 21 B.

CATCH BIOMASS

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	0	0	0	0	0	0	0	0	0	0	12	40	0	9	4	1
2	78	356	78	25	68	7	246	6	601	394	10	1569	319	1131	674	591
3	3393	1570	954	1975	12288	319	184	1512	652	1552	3091	85	3815	3746	1332	2219
4	1627	7544	4286	1981	8327	17323	1048	1732	1577	985	2485	2809	340	6197	5071	2463
5	2489	4476	12138	3784	3895	9605	19193	1866	440	1991	816	1921	3024	752	5891	5497
6	2733	2303	5131	9438	3574	1507	6089	15178	749	606	1129	1654	1171	2482	911	3338
7	3626	2618	2999	3847	6745	1323	1212	5152	7484	121	171	1320	472	704	2381	1058
8	2963	1394	2795	2290	1831	2157	1062	910	3433	6466	120	741	699	516	539	1234
9	1225	1076	1510	1713	1923	441	1546	610	306	2346	2682	647	571	198	256	382
10	357	334	998	757	1060	275	479	485	271	432	1434	1658	794	110	161	171
11	586	305	719	508	242	243	393	464	490	588	78	181	1766	578	160	85
12	173	189	504	308	161	66	188	310	77	438	714	44	91	847	412	32
1+	18550	22665	32042	25536	38863	33267	31640	28223	16280	15919	12739	12069	13014	17269	17991	20216
2+	18550	22665	32042	25536	38863	33267	31640	28223	16280	15919	12727	12029	13013	17261	17987	20216
3+	18472	22309	31964	25511	38795	33260	31394	28218	15678	15525	12717	10460	12694	16130	17313	19625
4+	15079	20739	31010	23536	26507	32941	31209	26706	15027	13973	9627	10375	8879	12384	15981	17405

	1978	1979	1980	1981
1	0	0	3	0
2	33	42	81	674
3	2905	1011	2028	1915
4	9351	9905	3986	7783
5	3879	7148	9665	7190
6	8592	2525	8350	7082
7	2906	3519	1464	3098
8	464	869	2050	1175
9	403	330	949	1194
10	108	282	143	359
11	36	55	93	63
12	22	6	19	106
1+	26600	24591	28532	30639
2+	26600	24591	28529	30638
3+	26567	24550	28449	29964
4+	22661	23538	26420	29049

MEAN WEIGHT OF INDIVIDUALS IN CATCH

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	1.39	1.30	1.43	1.42	0.99	1.00	1.19	1.33	1.48	1.61	1.49	1.33	1.38	1.20	1.43	1.50	1.59	1.69	1.81

	1981
1	1.62

MEAN AGE OF INDIVIDUALS IN CATCH

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	5.18	4.81	5.46	5.59	4.23	4.58	5.33	5.78	6.03	6.12	5.09	4.44	4.53	3.90	4.42	4.53	4.32	4.71	4.95

	1981
1	4.72

FISHING MORTALITY

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.000	0.001	0.000	0.000	0.000
2	0.004	0.039	0.002	0.000	0.018	0.003	0.053	0.002	0.103	0.043	0.005	0.091	0.021	0.125	0.033	0.028	0.003
3	0.088	0.077	0.091	0.056	0.163	0.053	0.050	0.225	0.160	0.228	0.263	0.031	0.193	0.182	0.131	0.104	0.025
4	0.085	0.192	0.233	0.201	0.259	0.275	0.164	0.254	0.281	0.263	0.440	0.275	0.111	0.341	0.258	0.136	0.256
5	0.185	0.269	0.410	0.269	0.579	0.411	0.402	0.360	0.181	0.422	0.271	0.496	0.366	0.255	0.437	0.314	0.412
6	0.218	0.261	0.460	0.444	0.297	0.368	0.383	0.493	0.188	0.300	0.344	0.500	0.468	0.408	0.381	0.741	0.511
7	0.492	0.382	0.400	0.427	0.640	0.456	0.467	0.427	0.377	0.034	0.100	0.677	0.335	0.417	0.577	0.435	0.667
8	0.409	0.358	0.487	0.575	0.504	0.328	0.157	0.423	0.268	0.526	0.035	0.814	0.253	0.583	0.541	0.556	0.531
9	0.452	0.361	0.664	0.539	0.410	0.256	0.426	0.105	0.369	0.819	0.353	0.522	0.913	0.300	0.510	0.938	0.373
10	0.264	0.180	0.619	0.779	0.686	0.168	0.449	0.207	0.054	1.101	1.503	0.318	0.379	0.376	1.065	1.733	0.619
11	0.564	0.198	0.636	0.716	0.520	0.345	0.338	0.986	0.292	0.133	0.496	0.614	0.530	0.423	1.138	0.826	1.241
12	0.392	0.307	0.502	0.531	0.488	0.267	0.358	0.430	0.385	0.420	0.208	0.491	0.592	0.432	0.507	0.743	0.519
6+	0.340	0.278	0.478	0.502	0.484	0.271	0.359	0.470	0.365	0.443	0.337	0.427	0.501	0.422	0.536	0.738	0.541

	1979	1980	1981
1	0.000	0.000	0.000
2	0.002	0.002	0.016
3	0.028	0.043	0.120
4	0.278	0.178	0.240
5	0.340	0.381	0.400
6	0.383	0.401	0.400
7	0.443	0.314	0.400
8	0.343	0.419	0.400
9	0.440	0.390	0.400
10	0.433	0.496	0.400
11	0.585	0.241	0.400
12	0.402	0.431	0.400
6+	0.407	0.317	0.400

Table 22. Comparison of numbers (x 10) at age 1 generated by CAFSAC Assessments since 1976.

ASSESSMENT	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	F_R
O'Boyle unpublished assessment #1 1977	30810	7007	60391	49293	28861	33393	-	-	-	-	-	-	0.28
O'Boyle unpublished assessment #2 1978	20810	7007	60231	35308	14606	26889	44755	-	-	-	-	-	0.33
Res. Doc. 78/19	33077	10775	75014	56364	34737	43539	83036	29423	-	-	-	-	0.3
Res. Doc. 80/2	26436	7169	50301	53352	28948	56167	73480	41293	50339	-	-	-	0.325
Res. Doc. 81/24	25436	6504	48605	47176	26207	50577	81785	41959	76120	45299	100000	-	0.300
Present Doc.	25524	6146	47857	46326	24960	54146	62978	38975	61878	31820	97036	91945	0.400

Table 23. Yield-per-recruit calculations and 1981 population parameters used in catch projections.

AGE	POPULATION AT AGE NO. IN '000's	CATCH AT AGE NO. IN '000's	WEIGHT AT AGE (KG)	PARTIAL RECRUITMENT
1	91,946	2	0.23	0.00006
2	79,431	1,143	0.59	0.04
3	21,190	2,176	0.88	0.3
4	31,814	6.177	1.26	0.6
5	13,897	4,180	1.72	1.0
6	10,606	3,190	2.22	1.0
7	3,887	1,169	2.65	1.0
8	1,241	373	3.15	1.0
9	1,088	327	3.65	1.0
10	323	97	3.70	1.0
11	47	14	4.51	1.0
12	74	22	4.83	1.0

Table 24. Catch projections at $F_{0.1}$ to 1983 under the 1981 conditions as outlined in Table 23. A value of 40 x 10^2 was taken for age 1 recruitment for 1982 and 1983.

Option	Year	1+ Population Numbers (10^{-6})	1+ Mean Population Biomass, t (10^{-3})	1+ Catch Biomass, t (10^{-3})
A	1981	256	160	31
$F_{0.1}$ in 1982	1982	232	176	27
	1983	215	183	32
B	1981	256	160	31
32,000 in	1982	232	173	32
1982	1983	212	179	30

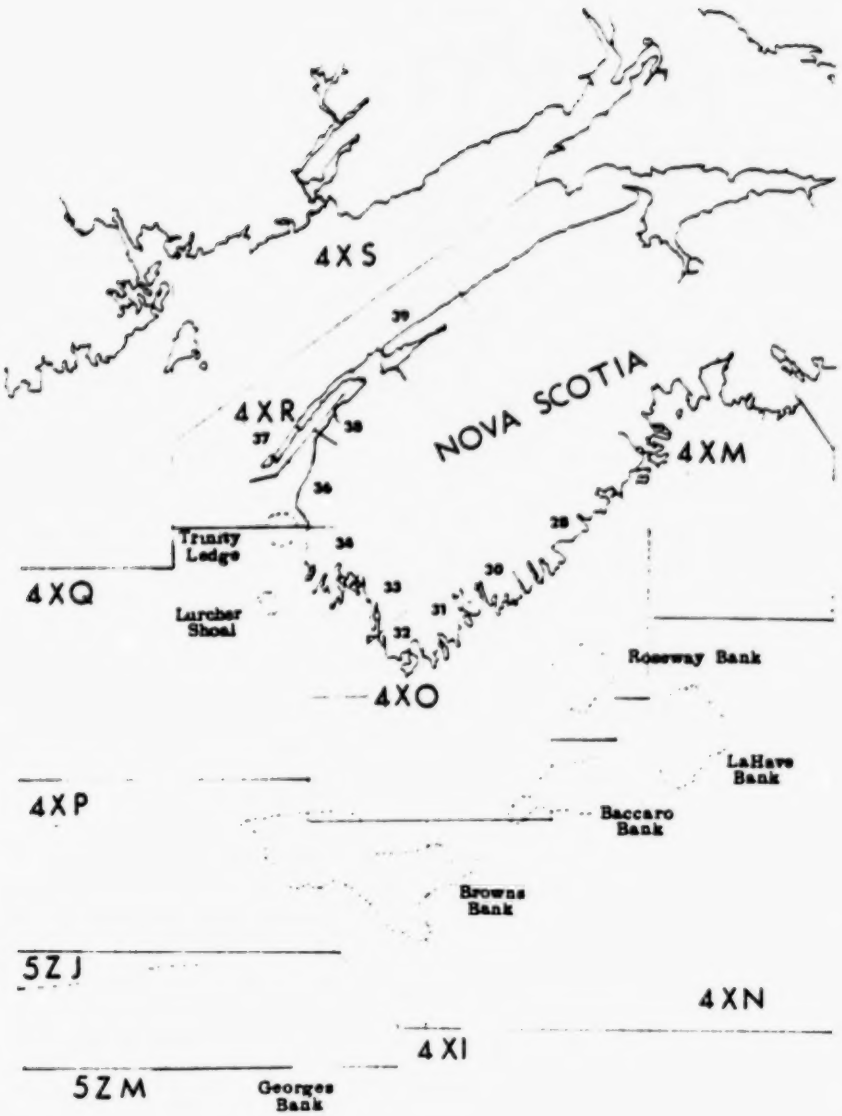


Figure 1. Canadian fisheries statistical unit areas in NAFO Division 4X and Georges Bank.

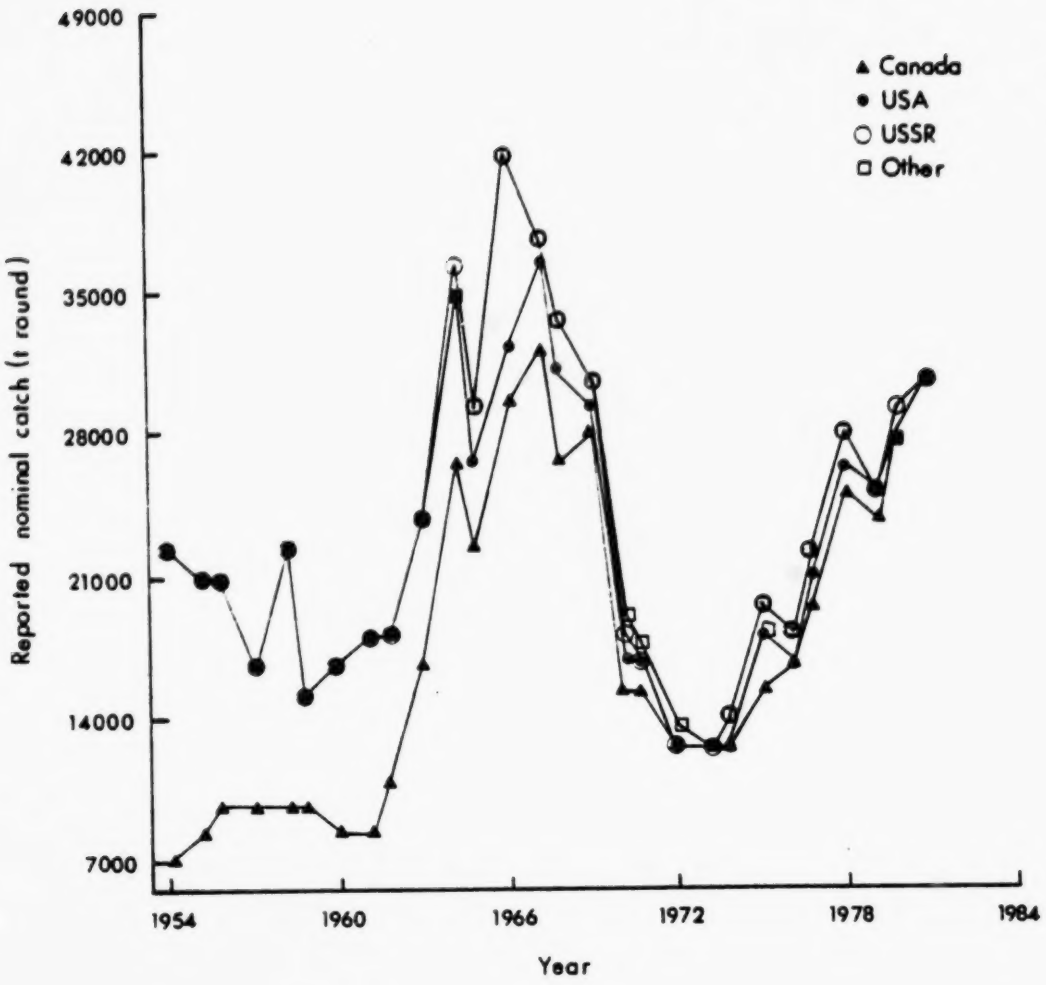


Figure 2. Cumulative reported nominal catches (t round) of haddock from NAFO Division 4X (excluding unit area 4Xs) by country.

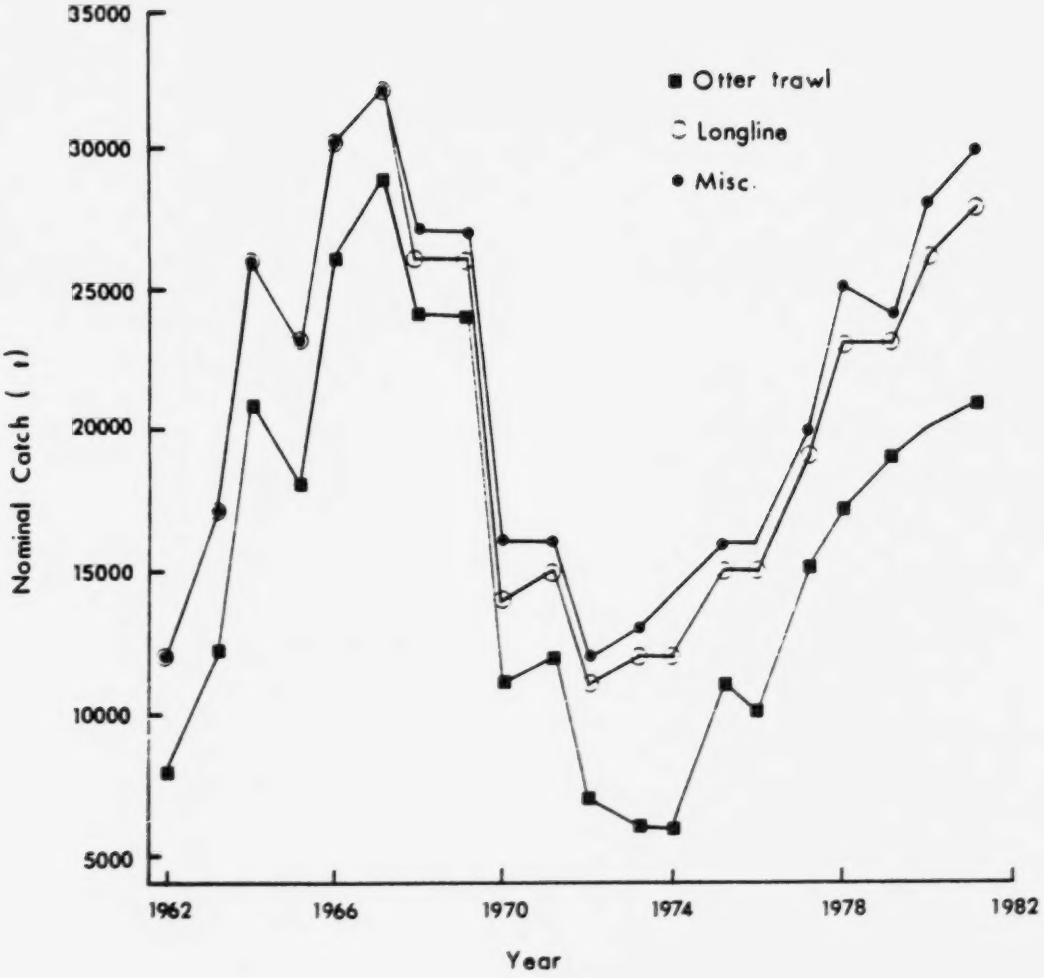


Figure 3. Cumulative nominal catches (t) of haddock from unit areas 4Xm-r for Canadian (MQ) fishing fleets during 1962-1981.

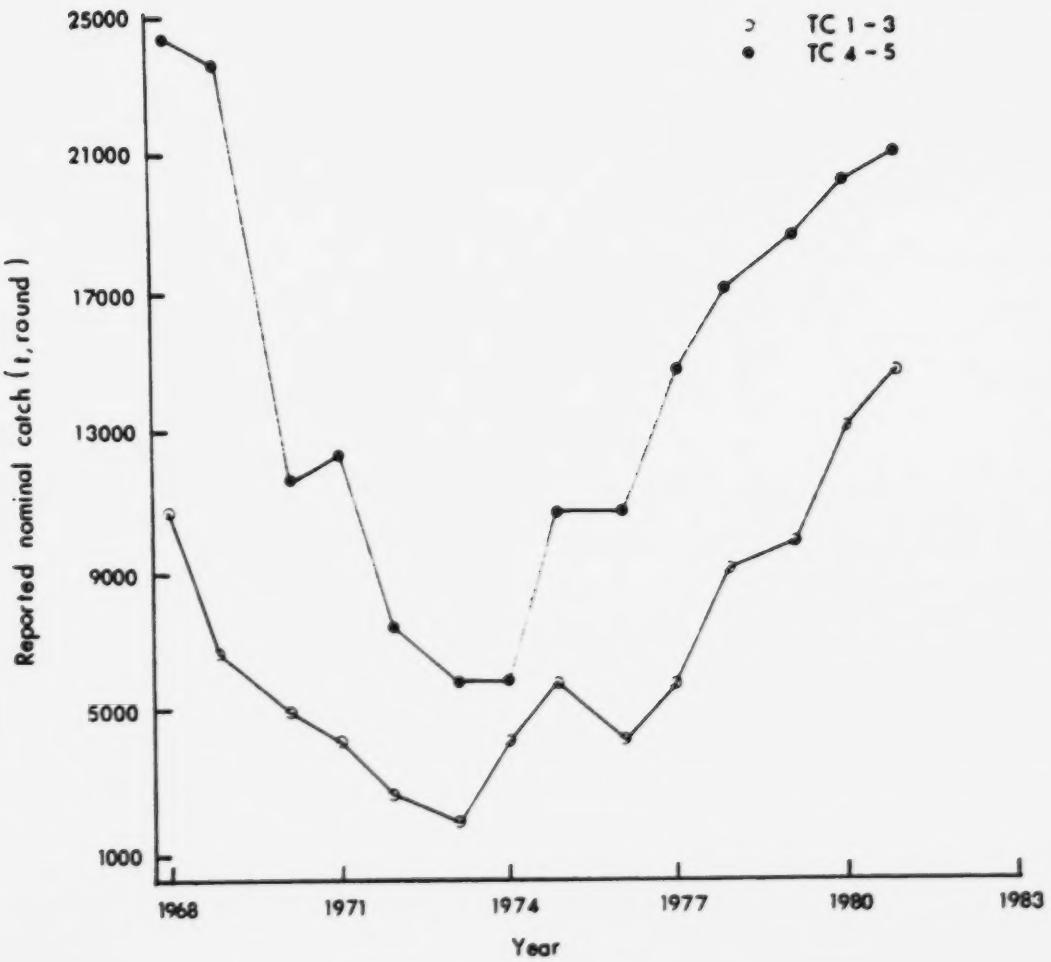


Figure 4. Cumulative reported nominal catches (t round) of haddock from unit areas 4Xm-r for Canadian (MQ) otter trawl fishery by tonnage class.

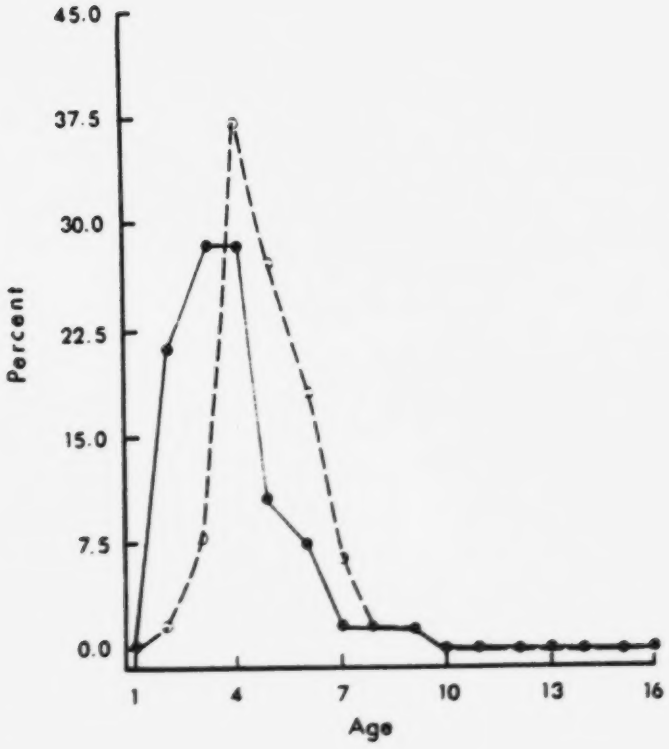


Fig. 5. Comparison of percent catch at age of 4x haddock caught by Otter Trawlers in unit areas Q - R (——) and unit areas M - P (----).

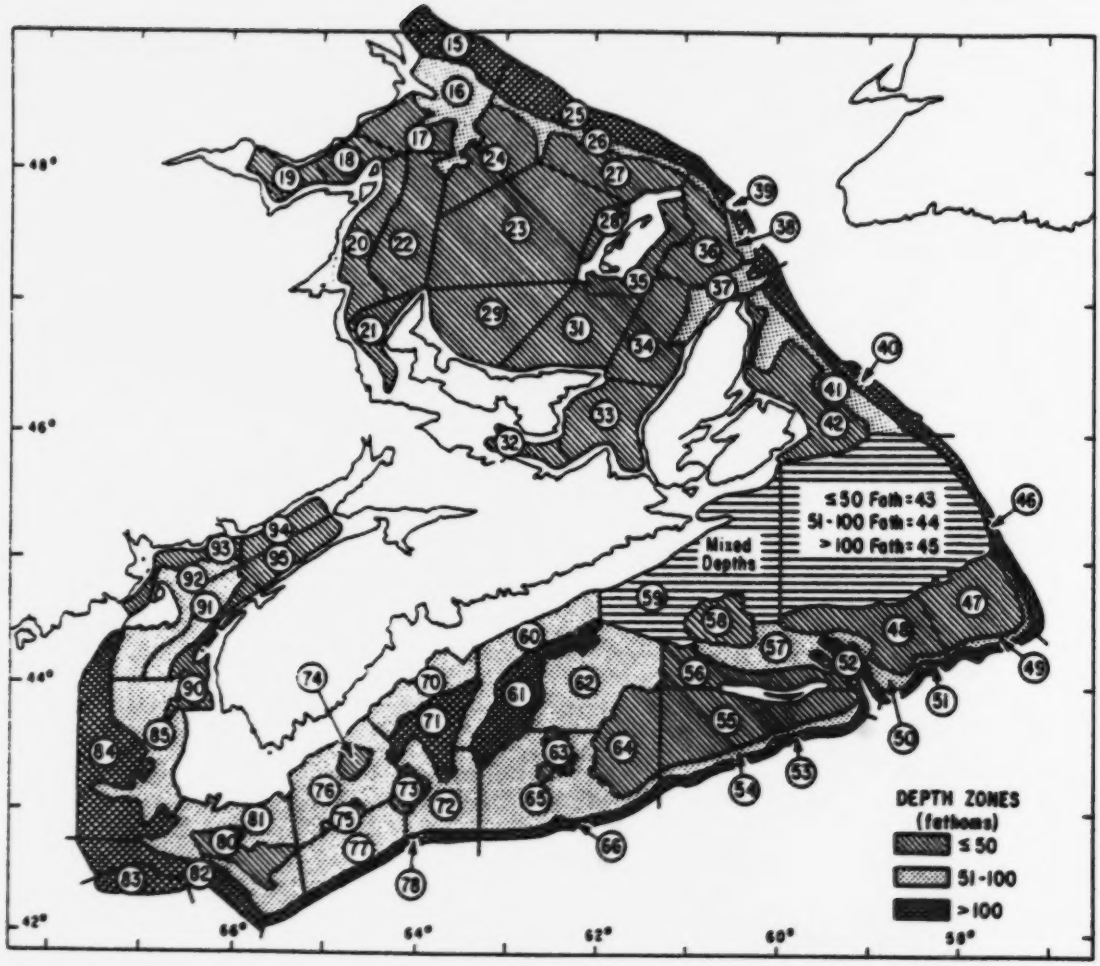


Figure 6a. Stratification scheme used during the Canadian bottom-trawl surveys.

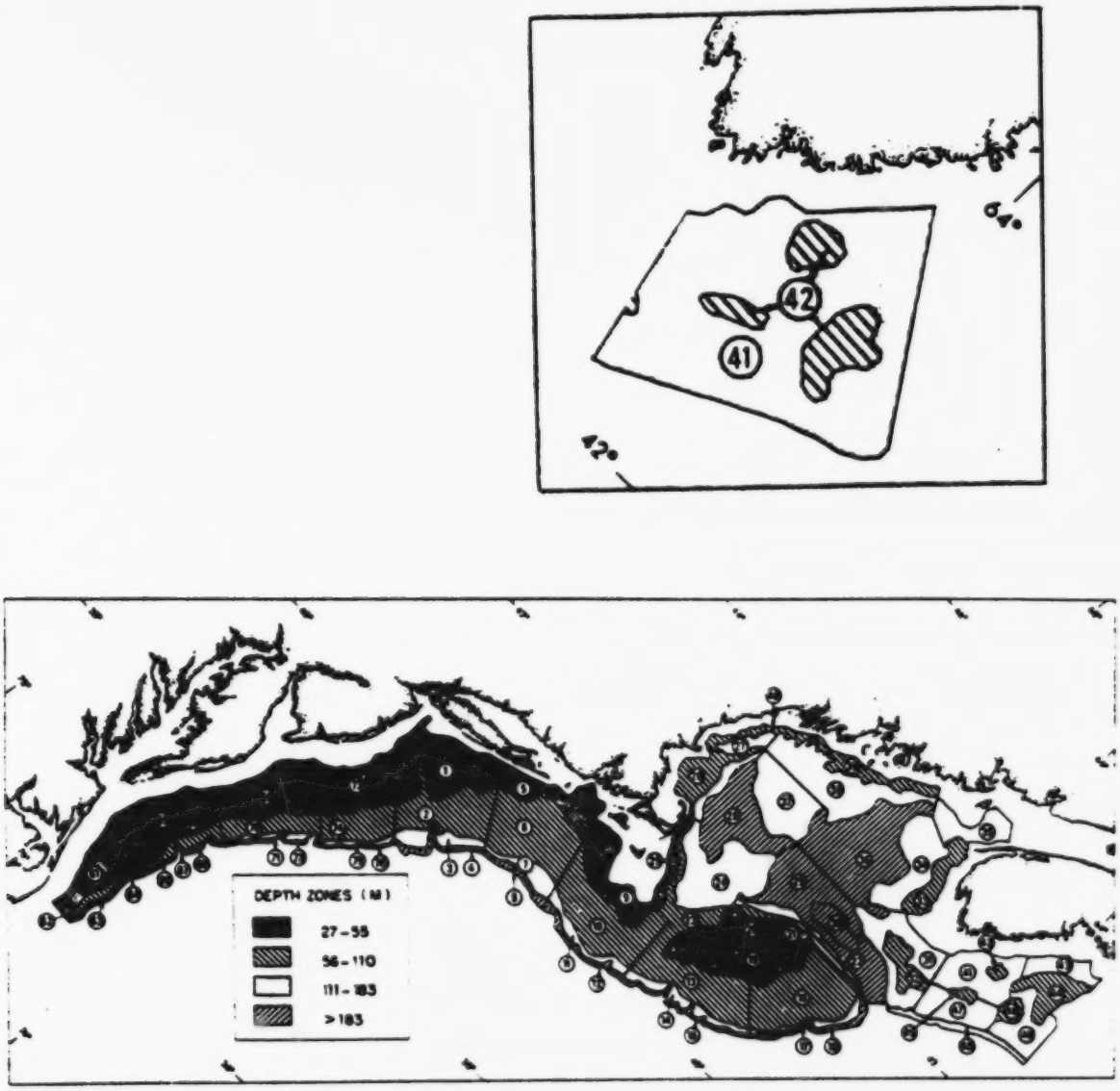
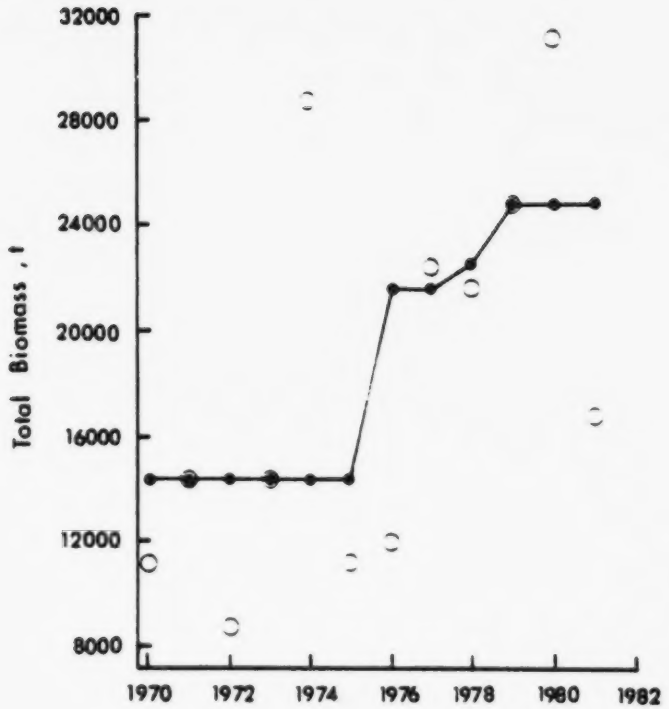


Figure 6b. Stratification scheme used during the U.S. fall bottom trawl survey. The stratification illustrated in the inset has been used since 1970.



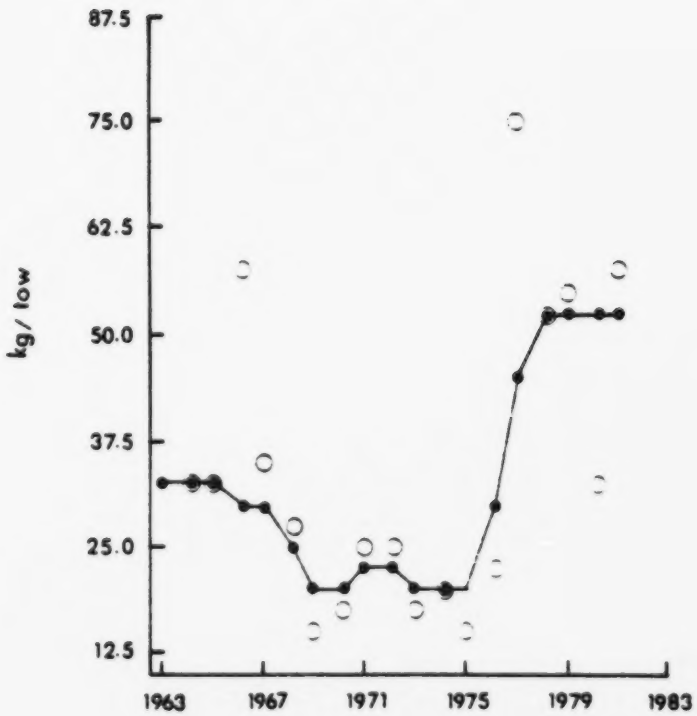


Fig. 7. Comparison of annual biomass trends for 4X Haddock on Browns Bank (Canadian strats 80-83) as determined by Canadian Summer and U.S. Fall Groundfish Research Surveys.

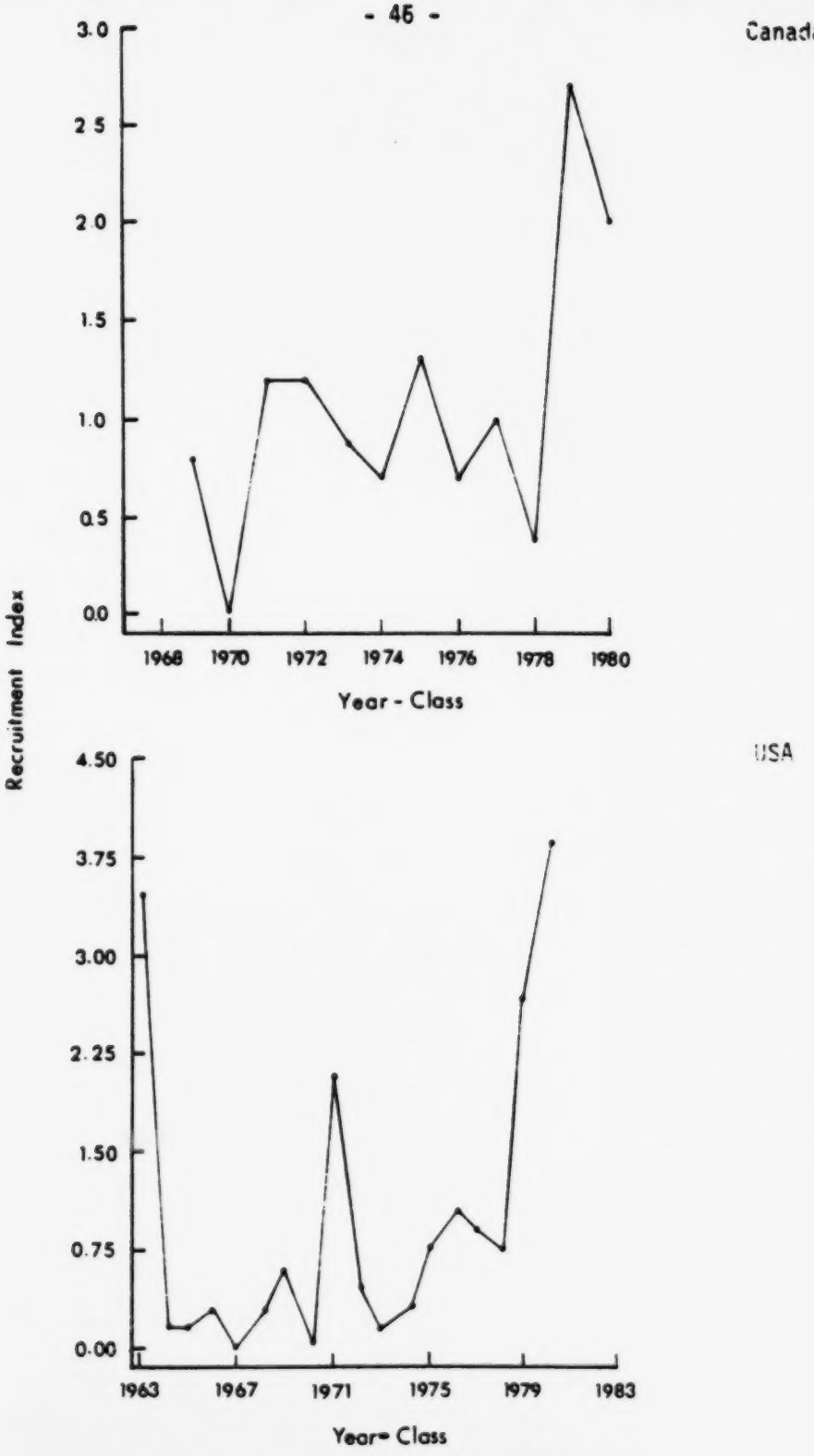


Fig. 3. Annual trends in Recruitment Indices of 4X Haddock determined by Canadian Summer (Ages 1 + 2) and U.S. Fall (Ages 0 + 1) Groundfish Research Surveys.

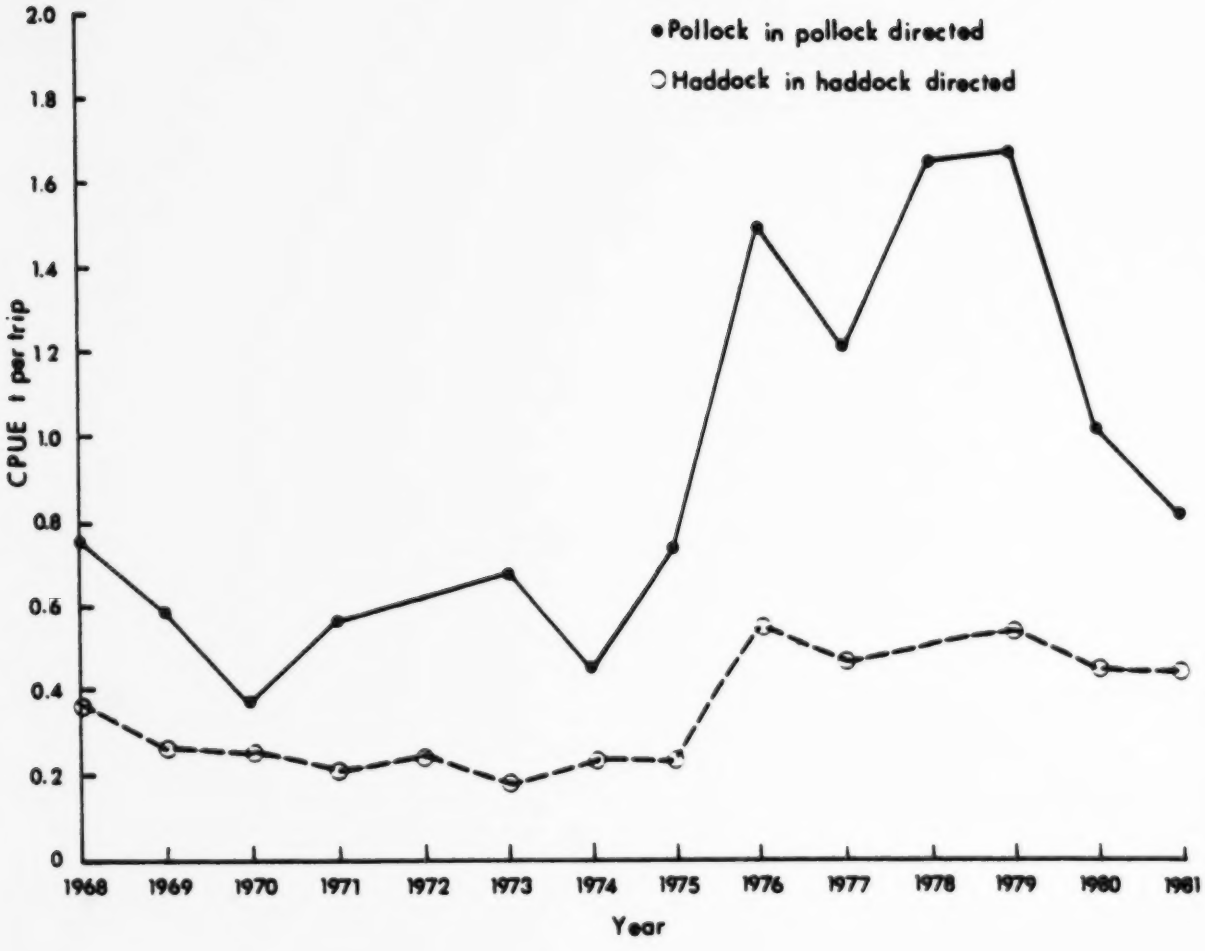


Figure 9. Catch rates (t per trip) of OTB2 vessels (TC 2+3) operating in 4Xq-r during May-August

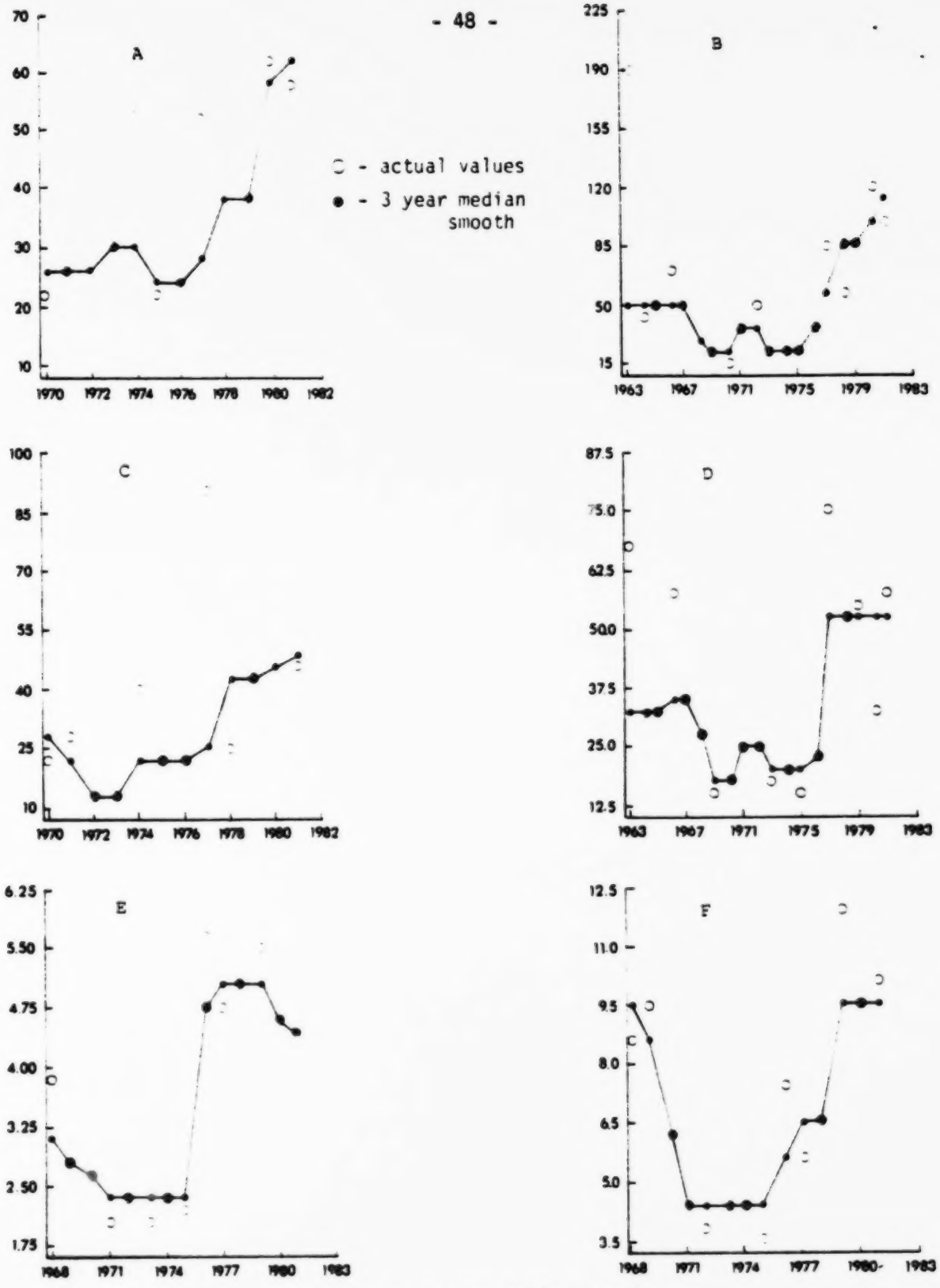


Fig. 10. Catch rate indices for the 4X Haddock stock -
A - Canadian Survey No. per tow; B - U.S. Survey No. per two;
C - Canadian Survey Kg per tow; D - U.S. Survey Kg per tow;
E - Otter trawl (T-C 2+3)t per trip; F - Otter trawl (T-C 4+5 t per day

Solid line joins points derived by three year median smooth.

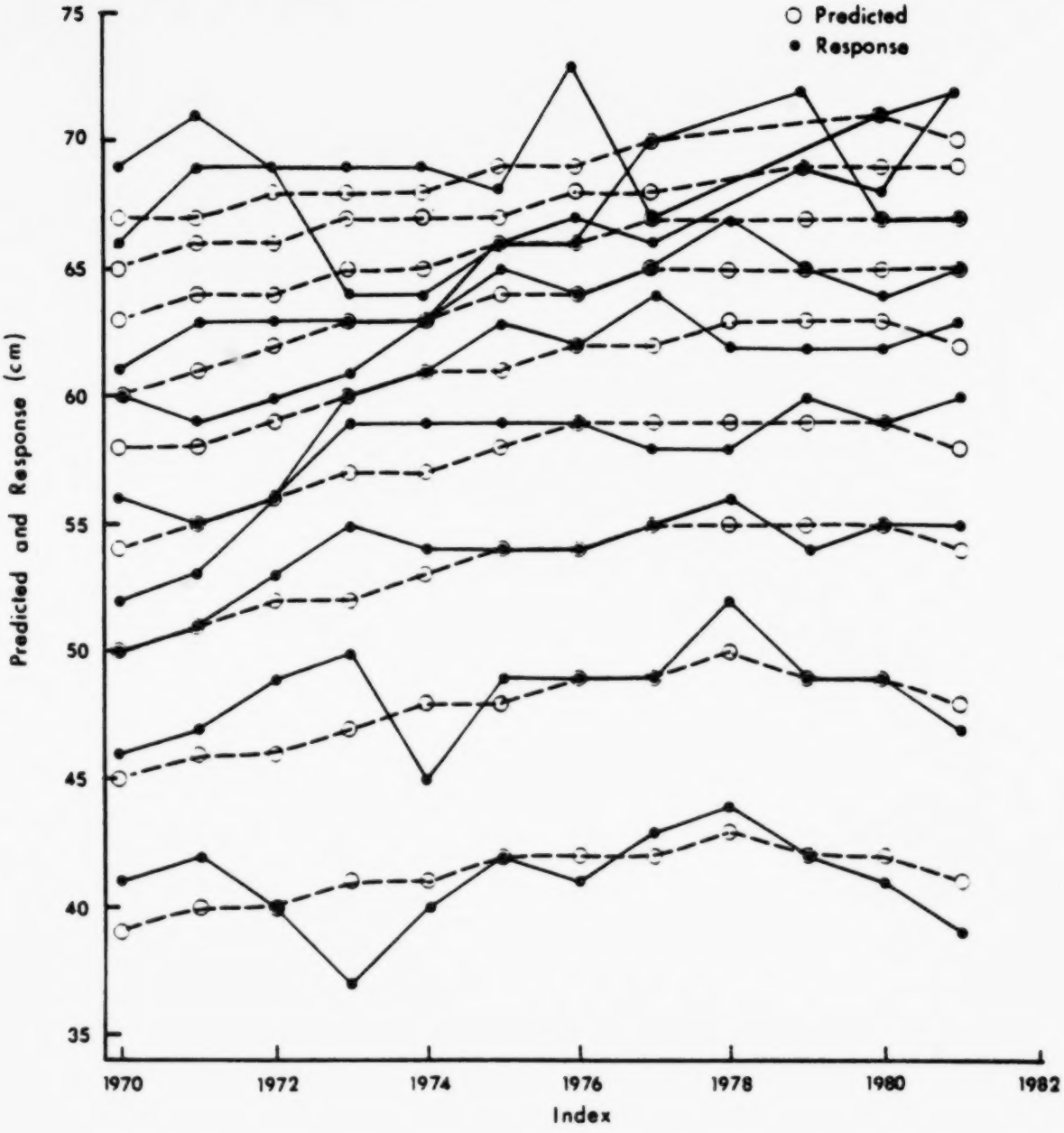


Figure 11. Response and predicted lengths from regression with time varying parameters. Dashed line connects predicted values for each age, solid line connects response values.

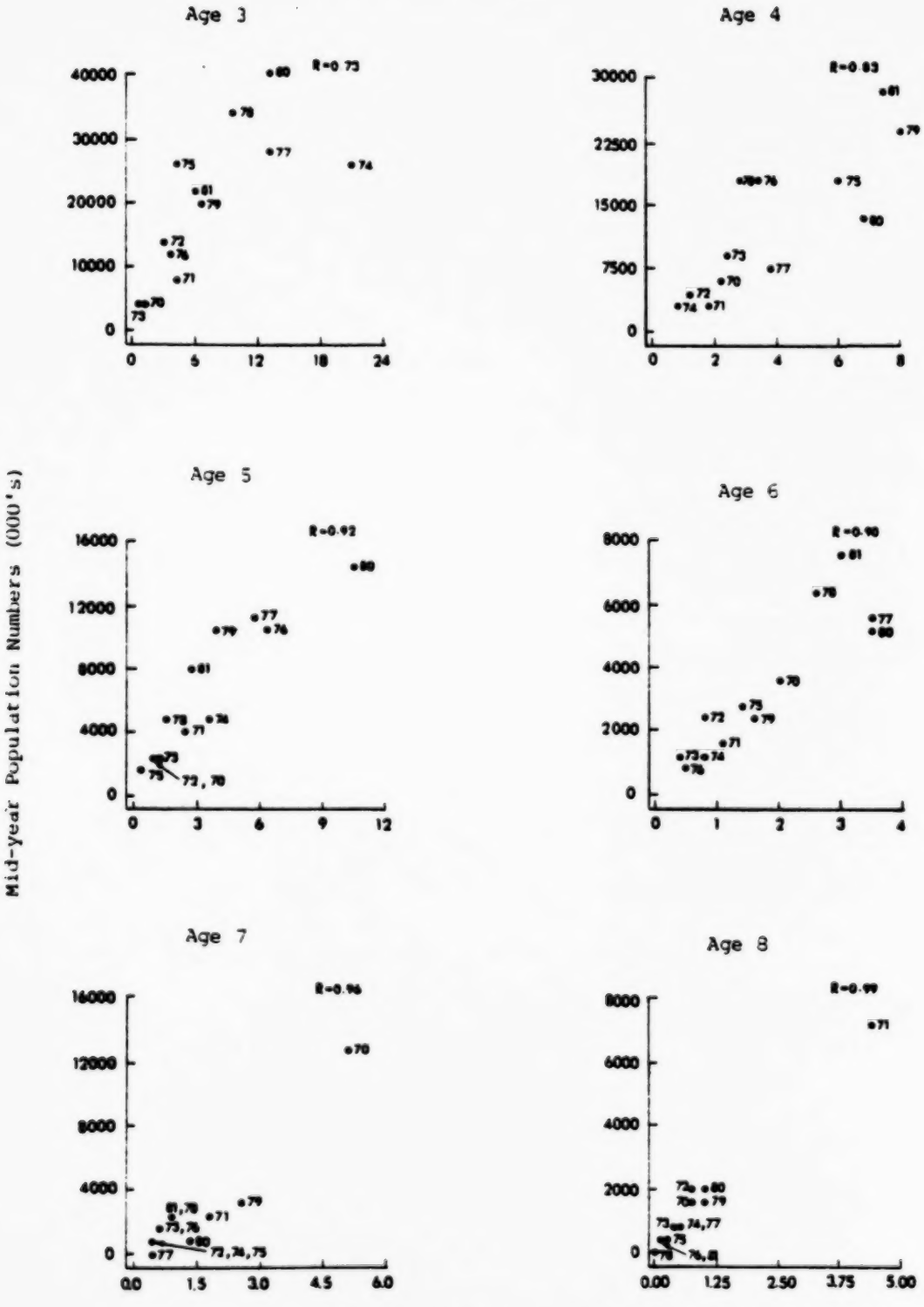
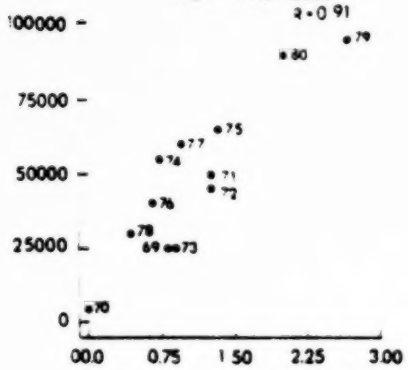


Fig. 12. Age by age comparisons of "survivor" derived mid-year population abundance estimates (numbers in (000's) for 4X Haddock with Canadian summer survey numbers per tow.

Age 1+2 Recruitment Index

vs

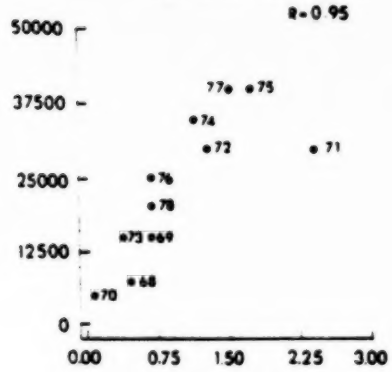
Age One SPA



Age 2+3 SPA

vs

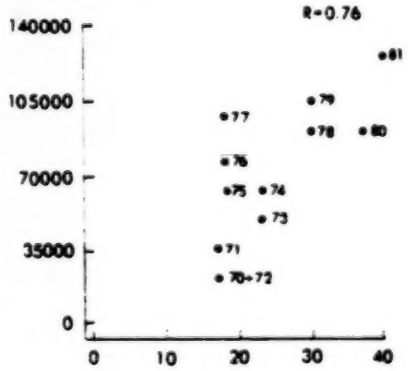
Age 2+3 Research



Ages 2 to 5 SPA

vs

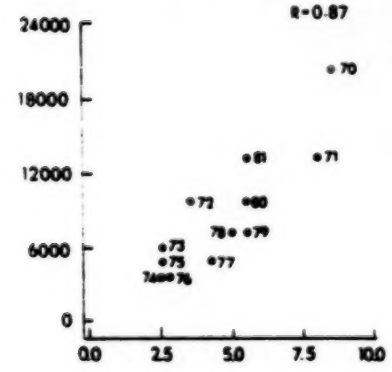
Ages 2 to 5 Research



Ages 6 plus SPA

vs

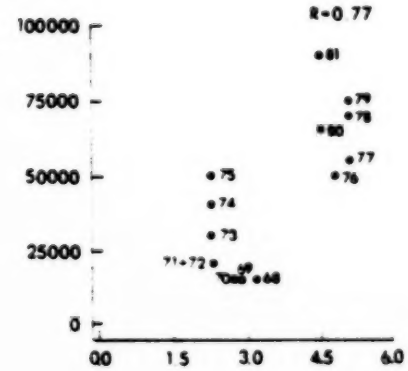
Ages 6 plus Research



Age 2-4 Pop. Biomass

vs

OT 2-3 Commercial Catch Rate, T/Trip



4+ Pop. Biomass

vs

OT 4-5 Commercial Catch Rate, T/Day

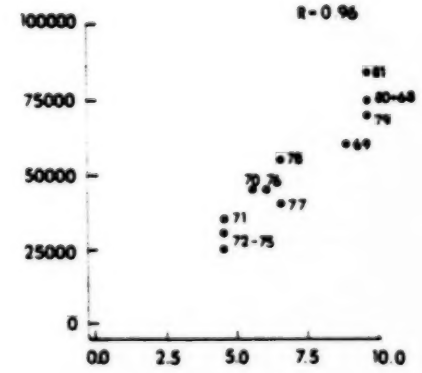


Fig. 13. Relationships generated by final Cohort Analysis run.